A CHECKLIST DEFINITION FOR ASSESSING MECHANICAL RISKS USING NTP 330 IN A REPAVEMENT CONSTRUCTION PROCESS

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In a construction project, such as a road repaving process, skilled and unskilled labor are the fundamental axis for the development of the project. Their intervention must be supervised by the probability of occurrence of occupational accidents due to the use of equipment, heavy machinery and tools required throughout the activities, which can have negative consequences on workers, manifested through temporary, permanent, and even fatal disabilities, and to contractors and employers, due to delays and economic losses in the project, in addition to possible sanctions by control agencies. Occupational hazards must be managed by a legal requirement in all countries. Hence, the need to identify, evaluate and propose risk control measures in all types of constructions. In this case, the study focuses on generating checklists to measure deficiency levels of mechanical hazards in the construction process of replacing flexible pavement with rigid concrete, according to the NTP 330 methodology, which is based on the application of the NTP 324 methodology of the National Institute of Safety and Health at Work (INSST) in Spain. These checklists will be the input for the assessment of mechanical risks by verifying the safety actions and conditions adopted in the construction project. Likewise, compliance with the requirements of these checklists will determine the basic requirements of the mechanical risk control process, prioritizing urgent prevention activities.

Keywords: Accident rate, Risk probability, Hazard, Hazard level.

1 INTRODUCTION

Addressing mechanical risks is justified to identify and assess potential hazards that may arise during various construction processes, which could lead to injuries, accidents, or fatalities if not properly managed. This represents losses, delays, and other dissatisfactions not only for the contracting company and its workers but also for the community where the project is being carried out. Managing mechanical risks is both a moral and legal necessity for anyone involved in project management, as it requires addressing a wide range of activities and multiple variables that may pose risks to workers. Even though the deficiency level (ND) can be obtained in a plethora of ways, it is generally considered ideal to use a checklist on a field evaluation, (according to NTP 324), which analyzes every possible risk factor in a given situation (Ocaña Sandoval 2019), so that multiple risks and their correlation can be visualized and controlled (Ligña Monta 2018).
2 CONSTRUCTION PROCESSES IN A ROAD REPAVING PROJECT

Before evaluating mechanical risks in the project, it is necessary to define the construction processes involved in the project and the risks present in them. The road construction process may vary its stages depending on the project conditions. The following are the construction processes for a rigid pavement application project on an existing road:

- **Preliminary Works:**
  - Layout and linear leveling
  - Installation of preventive signage on-site

- **Movement of Existing Layers:**
  - Milling of asphalt pavement
  - Mechanical excavation in soil
  - Disposal of milled and excavated material

- **Base and Subbase Formation and Compaction:**
  - Subgrade compaction
  - Placement of subbase material
  - Base layer compaction

- **Rigid Pavement Structure:**
  - Transportation and placement of concrete
  - Concrete pouring and vibration
  - Texturing and curing of concrete
  - Joint cutting and sealing

- **Signage and Protection:**
  - Dual-sided raised pavement markers
  - Vertical signage

3 IDENTIFICATION OF MECHANICAL RISKS THROUGH CONSTRUCTION PROCESSES (NTP 324)

The NTP 324 methodology, "Checklist Questionnaire for Accident Risk Control", focuses on identifying accident risk factors related to work organization and management, work facilities, and equipment, among other aspects. The risk factors can be grouped into four main blocks: material agents, personal characteristics, environmental surroundings, and organization. For the purposes of this investigation, the focus is exclusively on the material agents block, which includes the following sub-blocks: tools, hazardous substances, facilities, objects, and machines (Ardanuy 1997). Once the risk factors have been analyzed for each process, they can be grouped into the most prevalent risk factors, which are as follows:

- Collisions or accidents involving heavy machinery.
- Falls from the same height during work.
- Falling material during transport.
- Burns due to hot surfaces and materials.
- Projection of solid particles.
4 RISK EVALUATION CRITERIA IN CHECKLISTS (NTP 330)

The Technical Prevention Standard NTP 330 is a methodology aimed at the assessment and control of psychosocial risks in the workplace. Psychosocial risks are those that can affect the emotional, mental, and physical health of workers. The NTP 330 methodology is divided into four phases: the first phase focuses on identifying the mechanical factors present in the workplace; the second phase involves evaluating these factors through the application of questionnaires and interviews with workers; the third phase consists of analyzing the results obtained in the previous phase, all risk factors will be presented with scores on a scale of 1-10, where "very deficient" corresponds to a score of 10 and 1 as "acceptable". The level of deficiency (ND) represents the magnitude of the expected link between the set of risk factors considered and their direct causal relationship with potential accidents. The numerical values according to the NTP 330 methodology range from 1 (acceptable) to 10 (very deficient) (Belloví and Malagón 1997). However, in this research, the numerical values used have a range from 0 (acceptable) to 2 (very deficient). An additional criterion for risk evaluation is the level of importance (NI), which refers to the magnitude of how critical it is to answer each question to assess each risk in the project. It has a range from 1 (slightly important) to 3 (critically important). Subsequently, an incompatible level of deficiency is obtained concerning the NTP 330 criterion. Therefore, a proportionality based on the correlation of the maximum possible value in the checklist is applied, i.e., all questions have a deficiency level of 2. This results in obtaining the partial deficiency level for each question, which is the product of the Importance Level and Deficiency Level. By summing all the partial deficiency levels in the checklist, this value is then adjusted based on the maximum possible value in the checklist and the maximum possible deficiency value in the NTP 330. This process is carried out to obtain a compatible Deficiency Level result with the methodology used.

4.1 Checklist Structure

The structure of the model checklist goes as follows:

- Risk factor identified for evaluation.
- Level of importance at the evaluator's discretion, on a scale of 1-3.
- Level of deficiency not compatible with NTP 330, on a scale of 0-2.
- Partial deficiency level obtained as the product of Importance Level (NI) and Deficiency Level (ND).
- Total sum of partial deficiency levels for all questions.
- Maximum possible deficiency value analogy in the checklist.
- Compatibility achieved through proportionality between [5] and [6].
- Notation of the obtained rating according to the NTP 330 methodology.

4.2 Checklists for Mechanical Risk Assessment

For every risk factor evaluated, a series of questions based on their compliance are presented:

- Risk Factor: Collisions or runovers with heavy machinery
  - Have the personnel operating the heavy machinery received proper training and possess the necessary experience for its use?
  - Has a communication protocol been established and adhered to between the personnel operating the heavy machinery and the personnel in the work area?
  - Has a signaling and barricading protocol been established and adhered to for the work area where the heavy machinery is operated?
- Have the procedures for loading and unloading materials on the heavy machinery been established and followed?
- Has a protocol for maximum speed and allowed maneuvers been established and followed in the work area where the heavy machinery is operated?
- Have the necessary safety signs been established and adhered to in the work area where the heavy machinery is operated?
- Have the workers been provided with the required personal protective equipment (PPE) for each activity?
- Do all workers who operate a vehicle have a valid driver's license appropriate for their position?
- Do all operational vehicles have a reverse alarm?
- Is the construction signage installed in the project to ensure the safety of the workers?

- Risk Factor: Falling of transported material
  - Have the vehicles used for material transportation been inspected and found to be in good mechanical condition?
  - Have speed limits and traffic regulations for material transport vehicles been established and adhered to?
  - Are the transported materials properly secured and stacked to prevent their displacement or falling during transportation?
  - Have the personnel responsible for material transportation received proper training and possess the necessary experience to perform the task safely?
  - Has a communication protocol been established and adhered to between the personnel responsible for material transportation and the personnel in the work area?
  - Have the workers been provided with the required personal protective equipment (PPE) for each activity?
  - Is construction signage installed in the project to ensure the safety of the workers?
  - Does the loading equipment have protective covers/tarps?

- Risk Factor: Falls from the same height during work
  - Have preventive measures been established to control the risks of falls, including the installation of guardrails and the placement of safety nets?
  - Have the personnel been trained in the safe use of ladders, scaffolds, and other height-related work equipment?
  - Has a safety protocol for working at heights been established and followed, including the use of harnesses and other personal protective equipment?
  - Have the risks of tripping and slipping on the construction site been identified and evaluated?
  - Have preventive measures been established to control the risks of tripping and slipping, including the placement of non-slip surfaces and the removal of obstacles and spills?
  - Has a safety protocol for cleaning and maintenance of the construction site been established and followed, including the removal of debris and cleaning of slippery surfaces?
  - Have the workers been provided with the required personal protective equipment (PPE) for each activity?

- Risk Factor: Projection of solids
  - Have the workers operating the machinery used for the projection of solids received specific training on its handling?
- Do the workers use appropriate personal protective equipment (PPE) to prevent the projection of solids?
- Have physical barriers or protective shields been installed in areas where solid projection is carried out?
- Have the areas where solid projection is carried out been marked with signage to warn others of the associated risks?
- Are there preventive maintenance plans for the machinery used in solid projection?
- Have the workers been provided with the required personal protective equipment (PPE) for each activity?

- Risk Factor: Burns due to hot surfaces and materials
- Have the surfaces and materials that may be at high temperatures been identified?
- Have preventive measures been implemented to reduce the personnel’s exposure to hot surfaces and materials?
- Have safe work protocols been established for the handling of hot materials?
- Has the appropriate personal protective equipment (PPE), such as gloves and safety footwear, been provided for the handling of hot materials?
- Is there regular inspection of hot surfaces and materials to detect possible damage or failures that could lead to burn risks?
- Has a first aid protocol been established to promptly address a burn.
- Have the personnel been trained in the identification of burn risks, prevention, and first aid procedures?
- Has a system for reporting and tracking incidents or accidents related to burns been established?
- Does the workforce have certification for handling hot materials?
- Is signage present on all hot surfaces and materials?

5 APPLICATION IN THE FIELD

These risk factors are evaluated in accordance with the NTP 324 standard. Subsequently, a set of inquiries is formulated to ascertain the adherence to these risk factors at each construction stage. To gauge the significance of compliance, an Importance Level (NI) is assigned on a scale of 1 to 3. A rating of 1 signifies minimal criticality in terms of compliance, 2 denotes a relatively higher level of criticality, and 3 designates a matter of utmost importance in compliance considerations. Quantifying compliance entails associating a score on a scale of 0 to 2, indicating the Deficiency Level (ND). A score of 0 signifies full compliance, 1 indicates compliance with room for improvement, and 2 signifies non-compliance. Subsequently, field activities and risk-mitigation efforts by workers are monitored to determine the overall risk level, as detailed in Chapter 4 and aligned with the NTP 330 standard.

6 CONCLUSIONS

Checklists are provided to assess mechanical risks in a rigid pavement application construction process, which can be adapted to various road construction processes. This adaptation is possible because the core construction processes remain the same, but they present certain specificities tailored to different construction requirements.

Although it is possible to make the evaluation criteria more specific, in this study, simple and concise criteria have been considered to assist the evaluator in quantifying different aspects of this evaluation. This approach aims to provide the evaluator with a more straightforward way to
quantify the results, as having more possibilities for quantification may not necessarily reflect the reality accurately.

References


