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Ergonomic Assessment Of Activities In Shop Floor And Plan For Improvement In Rolling Stock Industry

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***Abstract*—This paper aims to evaluate the ergonomic hazards at shop floor level that affects the employees. Ergonomics in a manufacturing environment is an integral part of workplace safety. It is easy to overlook everyday actions that could lead to Musculoskeletal disorders(MSDs) in long term, cumulative disorders and injuries. Here the critical tasks that affects the employees are identified on the shop floor inspection by Ergonomic assessment questionnaire. Job Safety Analysis helps to breakdown the critical tasks into sequence of steps. Each steps are analyzed for hazards and recorded. Then they are evaluated by using Alstom Ergo checklist. Two activities are being considered for the ergonomic study that affects the employees- Spot welding and Equipment mounting. Assessment of both activities are carried out and improvement must be planned to control the effects caused by critical activities. This can be controlled by providing specific safety trainings, conduct campaigns on shop floor along with engineering controls in place.**

***Keywords*— Ergonomics, Job safety analysis, Assessment, Ergo checklist**

I. INTRODUCTION

Manufacturing is emerging as an integral pillar in the country's economic growth, thanks to the performance of key sectors like automotive, engineering, chemicals and pharmaceuticals. The Indian manufacturing industry generated 16-17% of India's GDP pre-pandemic and is projected to be one of the fastest growing sectors. Here the ergonomic assessment was done in a rollingstock industry at Sricity, Andhra Pradesh, a special economic zone (SEZ) established to improve the industrial growth within the state. Metro trains, e-locos, trams are manufactured in an Rolling stock industry. Ergonomics is an important aspect that need to be studied which has long term effect on the worker. Improper positions of the body can cause stress and injuries to muscles and other soft tissues. Since awkward postures can be common in a manufacturing environment, it is important to examine tasks to determine if ergonomic improvements can be made to alleviate these risks

II. PROBLEM IDENTIFICATION

Ergonomics is defined as the science of fitting a workplace to the user's needs, aims to increase efficiency and productivity and reduce discomfort.

A. Ergonomic Assessment:

Ergonomic Assessment is an assessment of a worker at the workstation to ensure their working postures are good with an comfortable work station. It is done to reduce a worker's exposure to physical hazards such as improper postures, repetitive movements, etc.. It is done by a team of members of various department such as Production, Safety, Indus.

B. Effects of Ergonomic hazards:

Ergonomic hazards does not cause physical injuries but affects muscles, bones, tendons and tissues. Many ergonomic hazards affect the musculoskeletal system causing aches or strains that may appear small and insignificant, to begin with, but can develop into serious ailments that can even cause permanent damage to the body. These effects does not occur on short term and ensure to have long term effect on the worker. These hazards can result in back pain, carpal tunnel syndrome, tendonitis, sprains and other debilitating injuries. Ergonomic hazards can cause consistent pain to workers, who often choose to work through that pain.

Problem Identification

Each shop floor has many stations that are either critical or non-critical in any industry. It is based on the activities being performed in such stations. Here most of the critical activities are selected based on ergonomic assessment questionnaire, Tab 1.

Many sub activities are being carried out in the main critical activity and each sub activities possess some hazards. Such hazards need to be identified and must be rectified. This includes ergonomic hazards in activity and workplace.

Steps involved in assessment is given in Fig 1. First, a questionnaire is prepared and given to workers for feedback. JSA is performed to identify the hazards of specific tasks within jobs in order to reduce the risk of injury to workers by

breaking down the job into steps. Then the ergonomic hazard level is identified by feeding the data from the questionnaire and JSA along with onsite assessment on the Ergo checklist. It then displays the score of the assessment. Based on the score obtained after the evaluation, actions are planned to reduce or control the ergonomic hazard.

III. OBJECTIVE AND METHODOLOGY

A. *Objective of the Project*

The Primary goal of the project work is to study ergonomic hazards experienced in the activities at shop floor.

1) To improve the ergonomic condition of activities in shop floor by suitable control measure.

2) To identify the ergonomic hazards that are related to the spot welding & equipment mounting activities.

3) To increase productivity and reduce absenteeism in the workplace and improve employee satisfaction at workstation during tasks.

4) To control the hazards by providing specific safety trainings, conduct campaigns on shop floor along with engineering controls in place.

B. *Methodology*

Normally, most of the ergonomic assessments are evaluated using ergo methods such as RULA, REBA, NIOSH equations. It is important to use the right tool for the job considering the nature of the work involved and parts of the body laboured

Fig 1 Steps involved in Ergonomic Assessment

Questionnaire

Here, the initial step in the ergonomic assessment is the questionnaire which is prepared for the workers to answer. The questionnaire(Tab 1)comprises of 13 questions that are related to body parts being involved in the activity. Ergonomic Assessment questionnaire is the simple form of assessment conducted directly at the workplace among the workers performing the activities. It consists of few set of questions based on their activities and position during the task. It includes the position of body parts during the task and how it affects them.

QUESTIONNAIRE OF ERGONOMIC EVALUATION FOR WORKERS

S. NO	QUESTIONS	YES	NO
1	Do you have neck problems due to extension of your head during the activity?		
2	Do you feel any discomfort due to static body posture for long time?		
3	Does your activity is performed continuously for long hours in same position?		
4	Do you have any discomfort due to continuous during the task?		
5	Do you have back pain during performing the activity continuously for hours?		
6	Do you have any problem when moving the equipment or tool during work?		
7	Do you have back pain when handling the equipment due to frequent torsion?		
8	Do you have wrist, hand pain after continuous holding of tools or equipment?		
9	Do you experience shoulder pain when holding the equipment?		
10	Do you perform an activity continuously in same position for long hours?		
11	Any repetitive movement involved in the activity being performed?		
12	Do storage, disposition or accessibility to parts are between knees and shoulders?		
13	Does your hand shiver/ tremble after continuously holding the part/ equipment in same position?		

Tab 1 Ergonomic assessment Questionnaire

Job Safety Analysis

Then, Job Safety Analysis is a process to identify the hazards of specific tasks within jobs in order to reduce the risk of injury to workers. The process of creating a job safety analysis report is generally broken down into four steps in Fig 2.

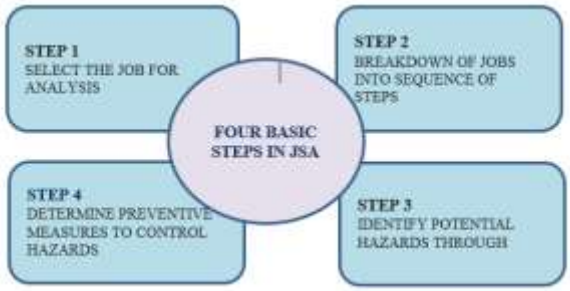


Fig 2 Steps involved in JSA

Ergonomic Assessment using Ergo Checklist

When identifying the hazards for each step it is vital to look for things that could go wrong. Lookout for unsafe behaviours and unsafe conditions that exist or might occur. Ensure each body parts are considered during the assessment Fig 4. Consider the following questions during assessment.

- What can go wrong?
- What are the consequences?
- How could it happen?
- What are other contributing factors?
- How likely is it that the hazard will occur?

Ergo Checklist is a programmed checklist that is being used to study the ergonomic hazard level of activity. It is done with the help of the questionnaire and JSA along with onsite assessment followed at the workstation. All the details are feed in the checklist and score is obtained for further studies.

Postures, position of neck, arm, wrist and shoulders, back position plays an important role in analysing the risk factors when working. Repetitive movement is considered when analysing risk factors when performing critical activities.

Then again the evaluation to be carried out in checklist Fig 3 and ensure the score is the acceptable level. Always ensure the assessment score should be below 4, as per rolling stock industry standard which implies the ergonomic hazard are in accepted level.

The evaluation score at each step by different department should be 4 or below. The scoring level are considered using the Alstom Global standard for Ergonomics that are below.

If these risk factors are present, the duration of exposure must be limited and the workstations must be designed in such a way as to reduce the effects on health either by designing tools or products.

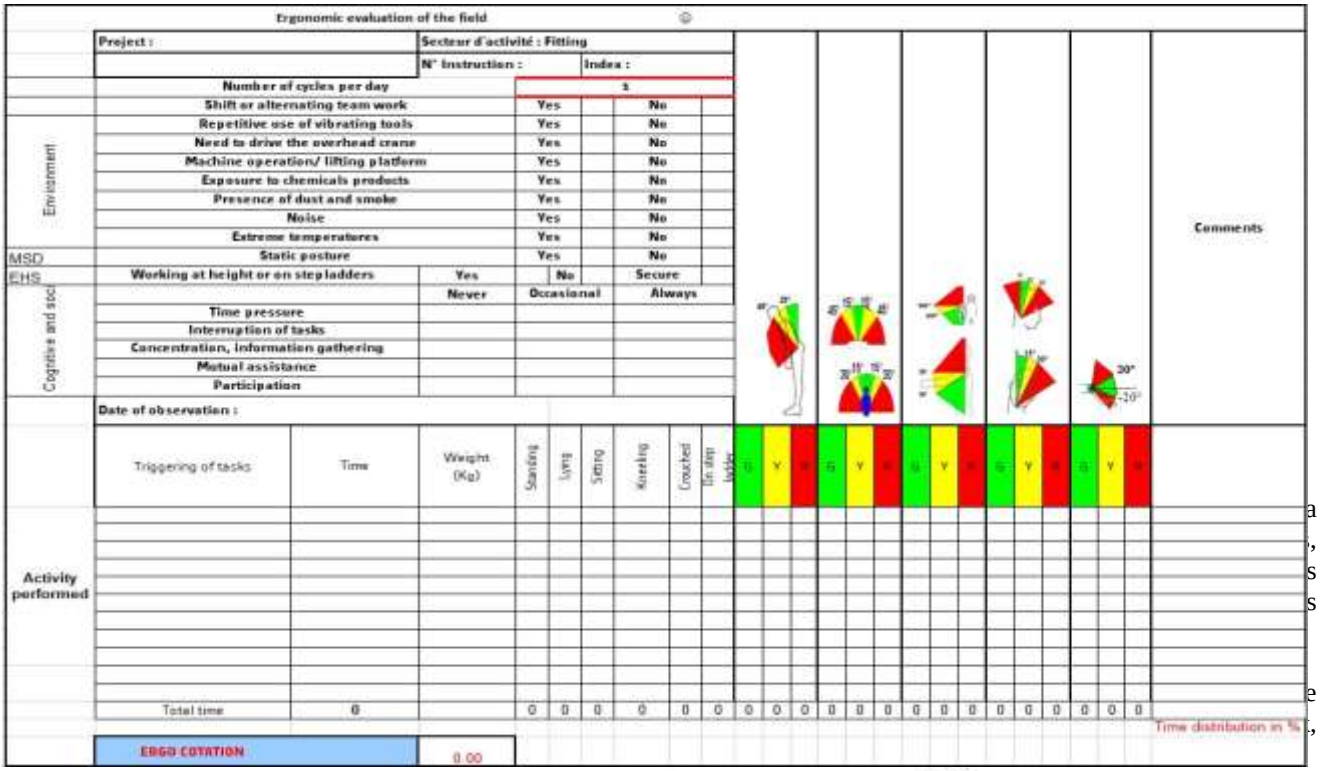


Fig 3 Ergonomic Assessment Checklist

Based on the questionnaire evaluation, two activities are considered for further ergonomic assessment- Spot welding and Equipment mounting.

JSA is then used to breakdown the activities in each critical activities and then the activities are entered in the ergonomic checklist specially designed for the assessment. It comprised the body part positions during the activity that can affect the health.

Postures, position of neck, arm, wrist and shoulders, back position plays an important role in analysing the risk factors and are used in the checklist, Fig 3. angle at which the body is position is noted and entered in Green, yellow or red zone

In addition, the process detail of the activity is entered into the checklist along with cognitive and organisational ergonomic details.

The activities that are identified to carryout ergonomic assessment are listed below

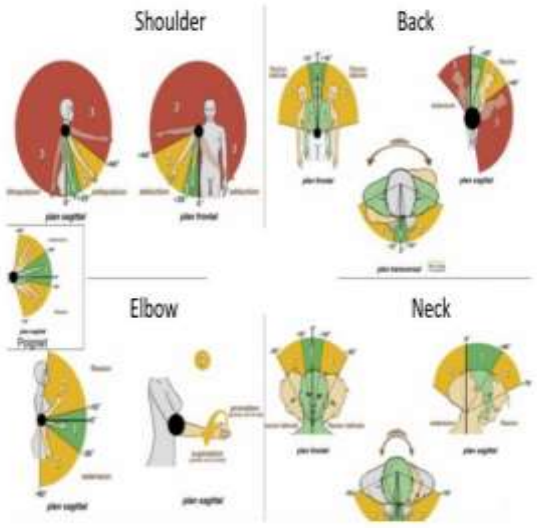


Fig 4 Position of Body parts with angles

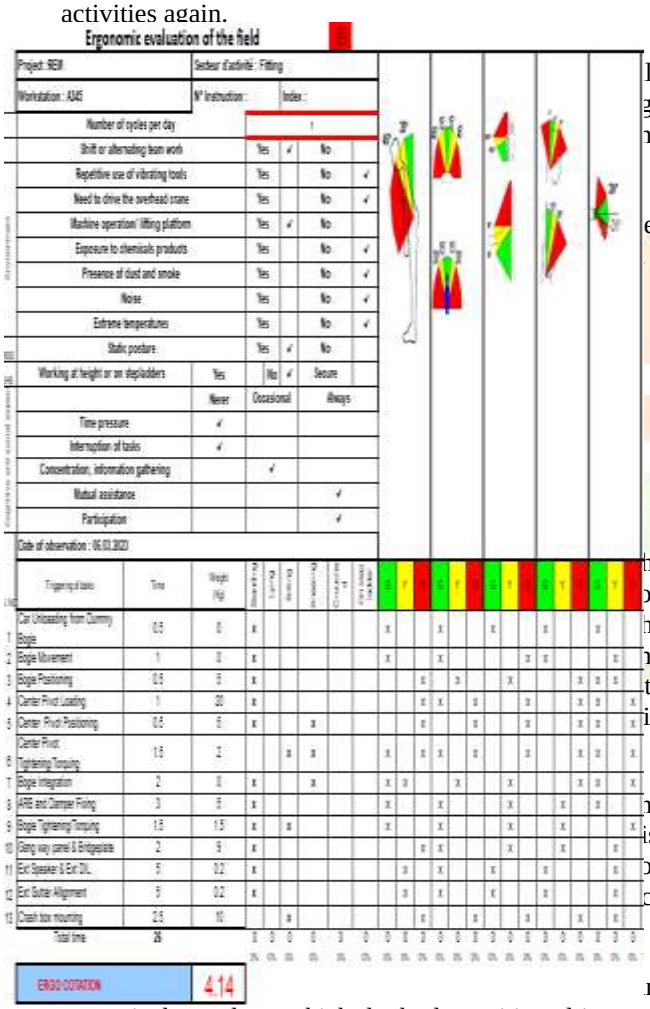
1. Spot Welding activity

Spot welding activity requires two employees to carry out the activity. One employee to hold the gun in standing position and the second employee sits below the module part to hold it from below. There is no provision made for the employee to sit below the part during welding. The spot weld process is a continuous process which will be carried out for around 7 hrs and posture need to be considered.

All the required details such as sub activities, cognitive and organisational ergonomic details are updated in the checklist and body part position for each activity is filled using the angle of part at each position.

- Loading of skeleton assembly- angle at which the body positioned is noted and entered in Green, yellow or red zone.

- The same method is followed for all the sub activities again.



screw jack- angle at which the body positioned is noted and entered in Green, yellow or red zone.

- The same method is followed for all the sub activities again.

- After completed entering the details, automatically the score will be displayed at the bottom as Ergo cotation Fig 6, which is 4.14 for the spot welding activity which is critical.

- Any further comments related to each sub activities shall be provided and recorded for easy understanding.

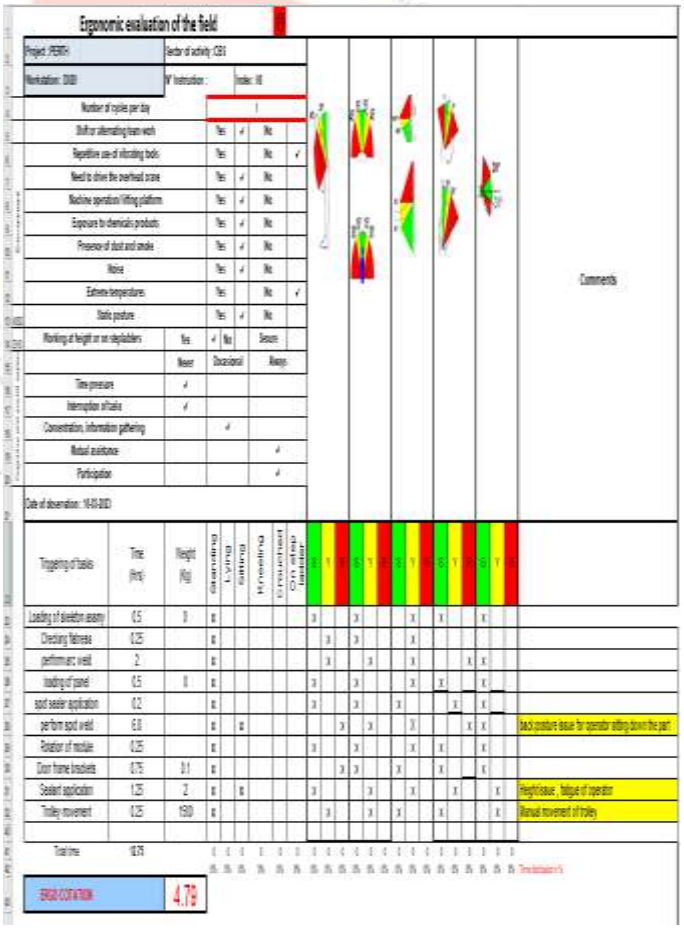


Fig 6 Ergonomic Assessment Checklist- Equipment Mounting

Graph to represent the ergo score of each part

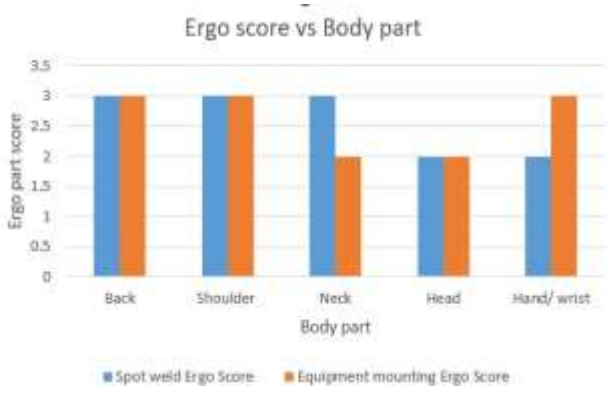


Fig 7 Graphical representation of Ergo score vs Body part

V. RESULT & DISCUSSION

After carrying out the assessment, control measures must be planned to reduce/ prevent the ergonomic hazard in the activity.

Following Hierarchy of control, five steps are being considered for any assessment and control measure.

- Eliminate the Hazard- Ergonomic hazard in both the activities cannot be eliminated as the activities must be performed manually by the team. It is mandatory to perform the task physically by the workers.
- Substitute the hazard- Substituting the activity or replacing the activity is not possible as the activity needs to be performed.
- Engineering Controls- Engineering control is the next step that needs to be considered for control measure. It is an effective method to prevent/ reduce the hazard in both the activities.

Spot Welding- Designing a movable sitting trolley with back support which can be used below the jig will help to reduce the ergonomic hazard to an extent.

Equipment Mounting- Designing a centre pivot lifting equipment that is battery operated which can help the crew to avoid holding the part till it is mounted helps to reduce the ergonomic hazard.

- Administrative Control- The most important and effective control are Education, Encouragement, Engineering, Enforcement and Evaluation.
- Educating the workers on the ergonomic hazards and the effects of it will help them understand how it affects and how to control them. It is also the duty the employer to study, evaluate the workplace hazard and ensuring proper actions to be taken.
- Personal Protective Equipment- This will be the last line of control which does not have impact in controlling the ergonomic hazard.

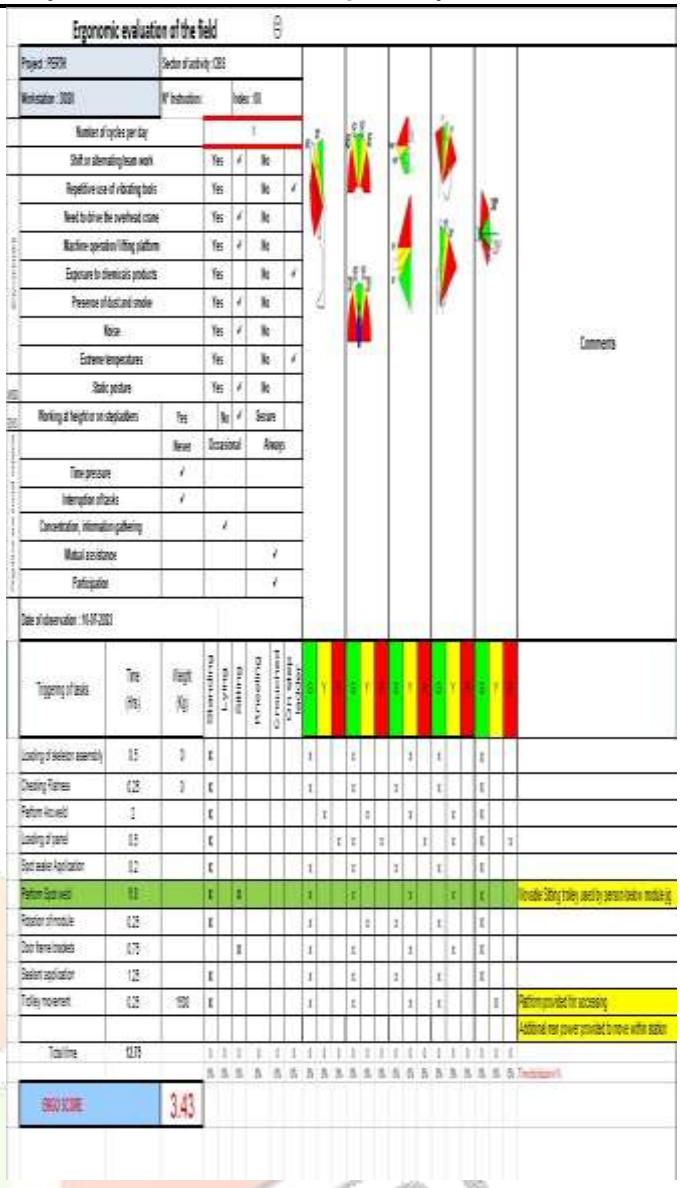


Fig 8 Ergonomic Assessment Checklist- Spot Welding(After designing tool and training)

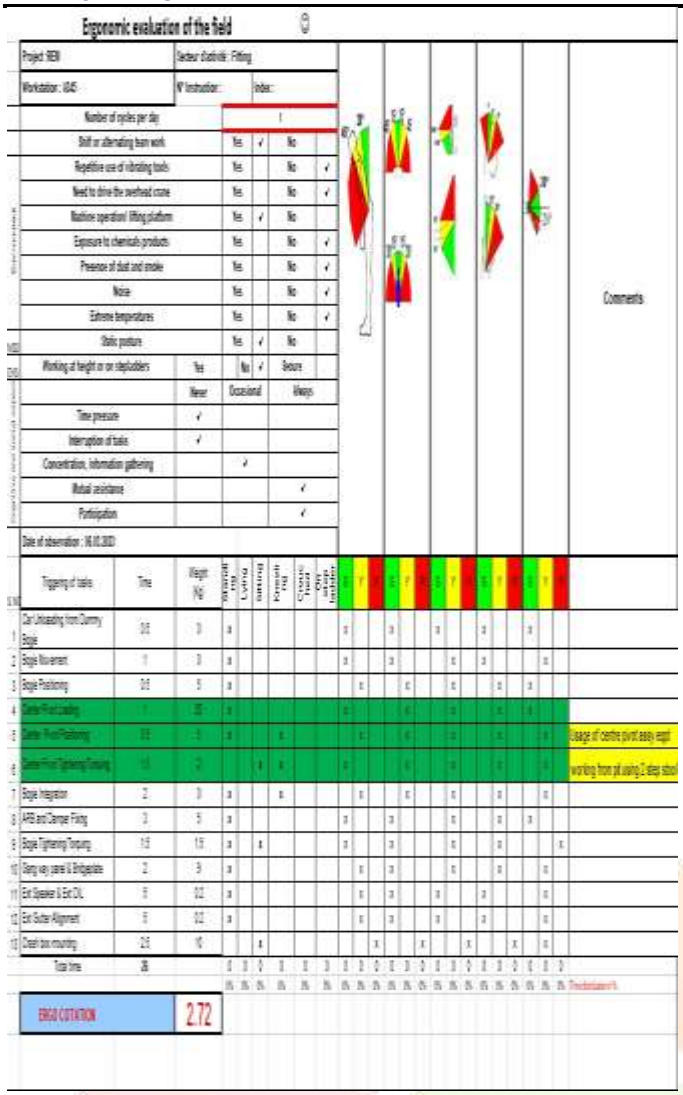


Fig 9 Ergonomic Assessment Checklist- Equipment mounting(After designing tool and training)

After the implementation of tools to perform the activity and training on the specific job, the assessment is done again with the Ergo checklist . The scores of Ergo checklist were below 4 and are controlled to an extent.
Continuous improvement can be achieved by conducting periodic assessment and taking appropriate controls.

These activities are performed continuously and takes longer time as much as an entire shift. The effects will be long term and affects them even after working hours. To control and improve the working condition, it is important to educate the workers on the work hazards. Ergonomic assessment of the task need to be done and educate the worker on the effects which they may already experience.

Then, assess and design an equipment that helps the workers to perform the task comfortably. When the tasks become safe, easier and comfortable to work, it not only helps the workers but also reflects in work time and productivity

Many ergonomic tools such as RULA, REBA, NIOSH are followed and arrived with results and here Alstom Ergo checklist is followed for assessment.

Here the study is performed for the defined activity and effects are observed. This does not conclude that they experience the mentioned risks but also many more. It gives detailed assessment for the selected task physically.

VI. CONCLUSION

Based on the article, it can be concluded that it is indeed important to increase awareness among the employees and employer of the company to emphasize on ergonomic hazards and its effects. When many ergonomic methods are practised, here Ergonomic assessment checklist is designed and used for the assessment with subsequent steps. Also employee involvement is also the key to the working environment. Open communication between management or employer and the workers throughout the ergonomic improvement process allows for a flow of information critical to identify contributing factors and solving problems. Having a team who administrates ergonomics can benefits the company because they can always come out with suggestions that can be easily implemented with minimal cost and mechanical intervention. 5 E's(Education, Encouragement, Engineering, Enforcement and Evaluation) are recommended and must be followed. This study is also essential in recommending suitable engineering control at workplace so as to assist and provide employees a better working surrounding. Through this ergonomics assessment, recommendations were given to ease the employees at work and to avoid any unnecessary potential ergonomics issues. Evaluation can be done again by the same Ergonomic checklist after implementation of control measures and assessing the effectiveness.

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