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Implementation of the Best Practices for Scaffolding in Construction Industries to Prevent Workplace Incidents

Mohit Soni[1] and Prof. Praveen Thatoad[2]
Student, Master of Technology in Industrial Safety & Engineering[1]
Shiv Kumar Singh Institute of Technology & Science, Indore, India[1,2]

Abstract: *This research project is undertaken to measure the degree of safety in the use of scaffolds in India and to correlate safe scaffold practice to construction management and labor. Fall from height is the leading cause of death for construction workers. Accident that relates to scaffold due to collapse or fall from scaffolding is the second leading cause of fall averaging 32% in five years 2003 to 2021- [NIOSH]. This study focus on accident that relate to five types of scaffolding that are commonly employed in construction site. The methodologies used in this research are interviews with the people involved in the construction site and questionnaires which are distributed to the construction management and workers. Literature review discovers that adequate training, competency of erecting and dismantling scaffold and sufficient inspection and maintenance of scaffold can prevent accident. This paper discusses about the scaffolding safety in construction sites in Penang. Safety of workers at construction sites is one of the major concerns in construction industry. It is well recognized that the construction industry is one of the most dangerous industries in which to work in. The reasons for these dangers are the hazards faced by the workers in this industry. The equipment of their use on the construction sites are the cause of many of these hazards. One of the equipment with which injuries and death commonly occur among workers is working with scaffolds. Scaffolds play its role by providing passageway, support the structure and as a working platform. They are commonly used for working at heights and where there is the potential risk for workers to fall from height during job done on scaffolding. Falls are the largest cause of accidental death in the construction industry. Therefore, a study has been carried out to investigate and to emphasize on scaffolding hazards and strategies to prevent the hazards. The main objective is to measure the level of safety factor by using scaffolding awareness among employers and construction workers through case study observations in medium sized housing projects and high-rise projects at construction sites in Penang. Questionnaires have been distributed among the employers and unstructured interviews have been conducted with safety officers and officer from the Department of Safety and Health. The results show that scaffolding safety management at the high-rise projects is in compliance with the act and regulation requirements in India compared to the medium sized housing projects. The study also shows that all employers are well aware of the safety and health regulations in construction sites including scaffolding safety and their responsibilities to reduce fatalities and injuries in the construction industry.*

Keywords: scaffolding in construction industries.

I. INTRODUCTION

Scaffolding is a temporary framework used to support people and material in the construction or repair of buildings and other large structures. It is usually a modular system of metal pipes. The basic materials are tubes, couplers and boards. Tubes are either black or galvanized steel in a variety of lengths with a standard diameter of 48.3 mm. Tubes are generally bought in 6.3 m lengths to be cut down to certain typical sizes.

Boards provide a working surface for users of the scaffold. They are made of seasoned wood by thicknesses of 38 mm, 50 mm and 63 mm with a standard width of 225 mm.

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The board ends are protected by metal plates called hoop irons or sometimes nail plates. Wood, steel or aluminum decking is used or laminate boards. Couplers are the fittings which hold the tubes together. The most common scaffold couplers are right-angle couplers, putlog couplers and swivel couplers.

Based on literature review, India scaffolding's management control is still in low level because accidents affecting the labors and scaffold's workers are mainly fatal injuries or death is cause by the lack of management control.

Safety is the most important factor to be concentrate by construction firms. Thus, management have to take precautionary steps to ensure that fatal accidents do not happen in the future.

The significant of the research project is to identify unsafe scaffold practices in creating safety scaffolding environment in construction sites and provide maximum safety to workers.

1.1 Objectives and Scope of Study

- To highlight the scaffolding safety aspect related to the construction workers and management.
- To determine the level of safety awareness of workers and management at construction site.
- To identify the methods in enhancing safety of scaffolding application.

The scope of the study includes:

- Scaffolding which are commonly used to build building in construction sites.
- Cases happening in Perak.
- Scaffolding maintenance process on site.

II. LITERATURE REVIEW

Basic Types of Scaffolds

According to Alberta Construction Safety Association, there are nine types of scaffolds which are commonly used in Canada (n.d.). They are standard tubular frame scaffold, standard walk-through or arch frame scaffolds, rolling scaffolds, fold-up scaffold frames, adjustable scaffolds, tube and clamp scaffolds, system scaffold components, mast-climbing work platforms and crank-up or tower scaffolds.

Standard Tubular Frame Scaffold

This type of scaffold is one of the most commonly used in construction projects. Standard tubular frame scaffold is usually fabricated in a variety of spans and configurations, which makes it easy to fit different site conditions. This kind of scaffold is easy for a scaffold crew to assemble, and simple for the trade workers to use. The most important strong point is its components can be lifted by the scaffold crew manually, which substantially increases productivity (Alberta Construction Safety Association, n.d.).

Standard Walk-through or Arch Frame Scaffolds

This kind scaffold is a variation of the first one. It is mainly used in masonry industry to meet their needs – providing larger height between each platform, as well as easier access of materials (Alberta Construction Safety Association (ASCA), n.d.).

Rolling Scaffolds

Rolling scaffolds are used when scaffolding needs to be moved around quite often. This type of scaffold is equipped with wheels. The advantage of this kind scaffold is it is flexible and cost efficient; once set up, it can be used in more than one location (ASCA, n.d.).

Folding Type Scaffold Frames

Trades like painters, electricians, and ceiling installers often need fold-up scaffolds. Similar to rolling scaffold, fold-up scaffold is easy to move and set up around the job site, or to travel from project to project. Nevertheless, its small dimension limits its usage (ASCA, n.d.).

Adjustable Scaffolds

Adjustable scaffolding is quite similar to fold-up scaffolding, though it takes some effort to erect. As the name implies, the height is adjustable; further, the whole system is relatively light and can be taken down into a limited number of components which are suitable for transporting (ASCA, n.d.).

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Tube and Clamp Scaffolds

Tube and clamp scaffolds are often used for irregular forms. The advantage is their infinite adjustable ability in height and width. Generally, tube and clamp scaffolding has more flexibility, but is more complex and time-consuming to build than the other types (ASCA, n.d.).

System Scaffolds

Although system scaffolds are not as flexible as tube and clamp scaffolds, they are becoming increasingly popular on construction sites. They can be adjusted to a wide range of irregular shapes, for example, circular, dome, and non-rectangular structures (Infrastructure Health & Safety Association, n.d.).

Mast-climbing Work Platforms

Mast-climbing work platforms are most popular among the masonry industry. The advantage of this type of scaffold is the entire platform can be fixed to the exact height required, which satisfies the human physiological character and enhances the safety (Infrastructure Health & Safety Association (IHSA), n.d.).

Crank-up or Tower Scaffolds

Crank-up/tower scaffolds are used in some Canadian masonry projects, though they are more popular in America (IHSA, n.d.).

Scaffold Accessories

There are four major types of scaffold accessories, which cooperate with the major types of scaffolds to provide access for construction. They are sidewall brackets, platform components, ladders and stair section access, and guardrails (IHSA, n.d.).

Sidewall/Outrigger Brackets

Sidewall or outrigger brackets are most often used in masonry projects. They help to provide a fixable working platform at a convenient height (IHSA, n.d.).

Platform

Aluminum/plywood platform is the main part used to build a work deck. Usually, they vary in size, weight, strength and species. The load carrying capacities are one of the main indexes, which depend on the material and size of the platform, the span, and the location of the load, where regular inspection is required to ensure safety (IHSA, n.d.).

Letters and Stair Section Access

Letters and stairs are important methods to access platforms. Some of the letters and stairs are built into the platform system, while others are attached as a separate component (ASCA, n.d.).

Guardrails

Guardrails are a vital component to keep trade men safe. According to Alberta Construction Safety Association (n.d.), one of the major causes of trade men falling from work platforms is failure to install guardrails. Guardrail components are usually easy to attach to the scaffold platforms.

Scaffold Safety Issue and Design

Most of the existing research relative to scaffolding issues has focused on scaffold safety issues, scaffold structure analysis, and scaffold design. For example, Son and Park (2010) investigated steel pipe scaffolding in Korea. They designed specific tests based on different variables by checking the torque of the clamps being surveyed and the criteria specified from standard. Their results proposed discovery and recommendation for future use focused on marginal load of clamps. Peng et al. (1996) presented a simplified analysis system for high clearance scaffolds, which simplified the calculation of the critical loads in practical design. Due to limited access of relevant requirements for suspended scaffold structural design, as they are separately documented in more than one regulation, Hill et al. (2010) organized and provided information of key OSHA structural provisions considering suspended scaffold support elements design.

Scaffold Management

Ideally, good scaffold management could reduce scaffolding costs from around 25% of the total direct man-hours to about 15%. This big improvement could be realized through data management. If all the direct work is effectively scheduled, planned, and collected in a central database, then it is possible to identify the scaffold needs and even erect scaffolding before a trade foreman requests it. A scaffold database is needed for this process to track information like who built the scaffolding, when it went up, components and materials used, and how long it lasted. Thus, the tracking

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of scaffold labor-hours, scaffold material rental cost, and management of scaffold yard materials would become an entire system (Ryan, 2009).

Temporary Work Estimate

To present temporary work estimation, basic knowledge of construction project estimates (Section 2.3.1), as well as indirect cost estimates (Section 2.3.2) must be introduced first.

Construction Project Estimates

Estimation is the procedure to provide a statement of the approximate cost, time or quantity of material needed to carry out a project. Estimation is usually related to decision making processes, for example bidding price, project cost, and project controlling and management policy (Carr, 1989). Estimation is a crucial process for the construction management team (Adeli, & Wu, 1998).

A large number of estimate tools and methods have been developed. These techniques range from simple floor area method to advanced intelligent systems. Recently, researchers have been focusing on the more sophisticated means, which tend to analyze a large amount of data using advanced computer technology and programming techniques (Kim, Seo, & Hyun, 2012). For example, Gunaydin & Dogan (2004) suggested a model trained by neural network methodology for cost estimating in early design stages.

III. SCAFFOLDING HAZARDS AND RECOMMEND PRACTICAL STRATEGIES

The high number of incidents of injuries and fatalities amongst construction workers has generally been due to the nature of the works (evolving), weather condition and variety of hazards involved. Construction workers who work on scaffolding are exposed to falling from heights, falling objects, scaffold collapse, overturning of tower scaffolds and electric shock or electrocution.

There are several strategies that have been determination to prevent and at same time reduce the death or injuries cases that is caused by scaffolds hazards.

Following are the summarized of the strategies:

1. Assign a competent person to oversee the scaffold selection, erection, use, movement, alteration, dismantling, maintenance and inspection.
2. Employees who are involved in activities such as erecting, dismantling, repairing, and inspecting scaffolds being trained to recognize hazards associated with those activities.
3. Make sure that scaffolds must be capable of supporting their own weight and at least four times the maximum intended load.
4. Scaffolds are to be erected, moved, altered and dismantled by competent and experienced personnel or personnel under the supervision of a competent person to ensure safe installation according to the manufacturer's specifications and other requirements and scaffolding collapse.
5. Provides a complete of fall protection system and personal fall arresting system for construction workers safety.

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6. Installation of toe-boards, screens or guardrail systems or through the erection of debris nets, catch platforms, or canopy structures to catch or deflect falling objects for preventing falling objects.
7. Scaffolds must be far enough from overhead power lines to prevent any conductive materials (e.g. building materials, paint roller extensions, scaffold components) that may be handled on the scaffold, at a distance greater than 10 feet from the power line.
8. Maintain scaffolds in good repair and only replacement components from the original manufacturer should be used. Any intermixing scaffold components from different manufacturers should be avoided.

RISK ASSESSMENT

Within this chapter the focus is on the risk assessment to address the problem statement of this master's thesis. The various tools mentioned in chapter 2 are used to guide this master's thesis to the right direction. This chapter is made up of the following:

- Risk identification;
- Risk analysis;
- Risk evaluation.

All components of this chapter are based on data gathered through reports from the scientific databases (Fabiano, Curró, Reverberi, & Pastorino, 2010) (Milazzo, Spasojevic-Brkic, & Ancione, 2015) (Milazzo, Ancione, Spasojevic-Brkic, & Valis, 2016) (Aneziris, et al., 2008) (Ruud & Mikkelsen, 2008) (Singh, et al., 2017) (Ardi, Sunaryo, & Ayu, 2017) (Dutch Safety Board, 2020) (European Maritime Safety Agency, 2020) (Mokhtari, 2011) (Frendo, 2016) (Suruda, Liu, Egger, & Lillquist, 1999) (Raviv, Fishbain, & Shapira, 2017) (Occupational Safety and Health Administration, n.d.) (Al-Humaidi &Hadipriono Tan, 2009) (Rausand, 2011) (de Jong, 2012) (Kjellén, 2000), held interviews and brainstorming sessions with the head of maintenance, the QHSSE advisor of M/S CROP SUSTAIN , and the most experienced user of M/s Crop Sustain gantry crane, observations made by the author in the company, informal conversations with the employees of M/S CROP SUSTAIN , analyses of internal documents of M/S CROP SUSTAIN , incident reports from 2016 up to and including 2020, common sense, assumptions, and based on best knowledge of the author.

IV. EXPERIMENT

This chapter presents case studies on Implementation Scaffolding and Work at height safety practices at Construction Worksite to prevent workplace incidents and improve safety culture in M/s Crop Sustain Ventures PVT.LTD which is used to illustrate the developed risk assessment and management methodology, including an evaluation of important safety risks using the many methods which have been incorporated into the model. The case study materials were collected from the particular in projects site of the M/s Crop Sustain Ventures PVT.LTD. The results of the safety risk assessment are safety risk scores for overall project Scaffolding erection and Dismantling activities. hazard groups, hazardous events, and types of safety risk with a confidence percentage through Implementation of best practices for scaffolding erection/ dismantling and using for preventive work at height incident in at Construction Worksite to prevent workplace incidents and improve safety culture.

Introduction

Work at height contributes major industrial injuries all around the world. The major hazard of it is fall of person / material from height, collapse of structure etc.

The main causes are improper / no access to the job location, improper/poor quality of scaffolding or ladder.

Ladders and scaffoldings are often used in many plants and may lead to accidents if not used properly. This procedure outlines the safe work practices while working at heights with the use of ladders and scaffoldings.

OBJECTIVE:

The objective of this procedure is to ensure safe practice for erection, use and dismantling of scaffolds, ladders and man basket for providing access and for supporting workmen, equipment and materials for any construction work, maintenance, repairs and demolition to prevent fall from height and reduce the consequences if a fall occurs.

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SCOPE:

- This procedure is applicable to all activities which require person to work at height or at such locations where permanent working platform etc., are not provided and wherefrom risk of fall exist.
- The special situations of working at height like steeplejack work shall be handled differently and not under the scope of this procedure. These shall be done by specialists who have specific
- skills, procedures, equipment and rescue plan to manage the risk of work at height. Its scope covers the whole CROP SUSTAIN VENTURES PVT.LTD

SCAFFOLDING SAFETY:

Definition of Scaffold (IS: 3696)

A temporary structure consisting of standards, ledgers, generally of timber or metal to provide a working platforms for workmen and materials in the course of construction, maintenance, repairs and demolition, and also to support or allow hoisting and lowering of workmen, their tools and materials.

There are mainly five types of scaffolds with respect to its application:

a) Tubular scaffold
b) Out rigger scaffold
c) Suspended scaffold
d) Rolling scaffold (Mobile scaffold)
e) Trestle scaffold

Scaffolding parts (Terminology)

Standard (or Vertical or Post or Upright)

An upright member used for transmitting the weight of the load from the working platforms to the base of the scaffolding.

Ledger (or Horizontal or Runner)

A horizontal member placed in the longitudinal direction at right angles between standards for the purpose of supporting putlogs.

Putlog (or Bearer or Transom)

A horizontal member placed in the transverse direction between ledgers, standards, or other supports and used to support a working platform.

Bracing:

A member placed diagonally with respect to the vertical or horizontal members of a scaffold and fixed to them to afford stability.

Coupler:

A fitting used to fix scaffold tubes together.

Swivel coupler:

A coupler for joining tubes at an angle other than a right angle.

Right-angle coupler:

A coupler used to join tubes at right angles.

Top Rail (or Guard Rail)

A horizontal rail secured at height of 1200 mm with standards and erected along the exposed edges of scaffolds to prevent workmen from falling.

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Mid Rail:
A horizontal rail secured at height of 600 mm to standards and erected along the exposed edges of scaffolds to prevent workmen from falling.

Toe Board (or Toe Guard / Toe Rail)
A barrier (height 150 mm) placed along the edge of scaffold platform and secured there to guard against the falling of material and equipment.

Self-Closing Drop Bar (or inside Post):
A horizontal rail secured at height of 1200 mm with false upright and erected along the exposed edges of scaffolds with movable in up and down direction to allow worker to enter working platform also prevent workmen from falling.

False Upright (or Puncheon)
A false upright member used for making entrance of the working platforms from the ladder of scaffolding. It is with same height of top rail (1200 mm) and secured with top rail, mid rail and ledger (runner) of working platform.

Base Plate:
It is mild steel (MS) square plate of 100 mm X 100 mm X 6 mm thickness with 38 mm dia. And 75 mm long spigot supporting at bottom to the base plate in unpaved area.

Sole Plate (or Sill)
It is a mild steel plate of 300 mm X 300 mm X 6 mm thick, provided below the base plate in unpaved area used to distribute the load from a standard or base plate to the ground.

Lift:
The assembly of ledgers and putlogs forming each horizontal level of a scaffold. The lift height is the vertical distance between two lifts, measured center to center.

Base Lift (or Kicker Lift):
The assembly of ledgers and putlogs forming first horizontal level of a scaffold at 150 mm from ground level.

Working platform:
That part of a scaffolding on which workers and/or materials are supported for the purpose of carrying out construction work.

Span:
Means the distance measured along the member between the center lines of adjacent supports of the member.

Tie:
The attachment by which scaffolding is attached to a structure; it also means “tie and spreader” and includes the attachments used in conjunction with the spreader or putlog extension to secure a scaffold to a building or structure to prevent movement.

Bay Length:
Means the distance measured between the vertical members of scaffolding from centre lines.

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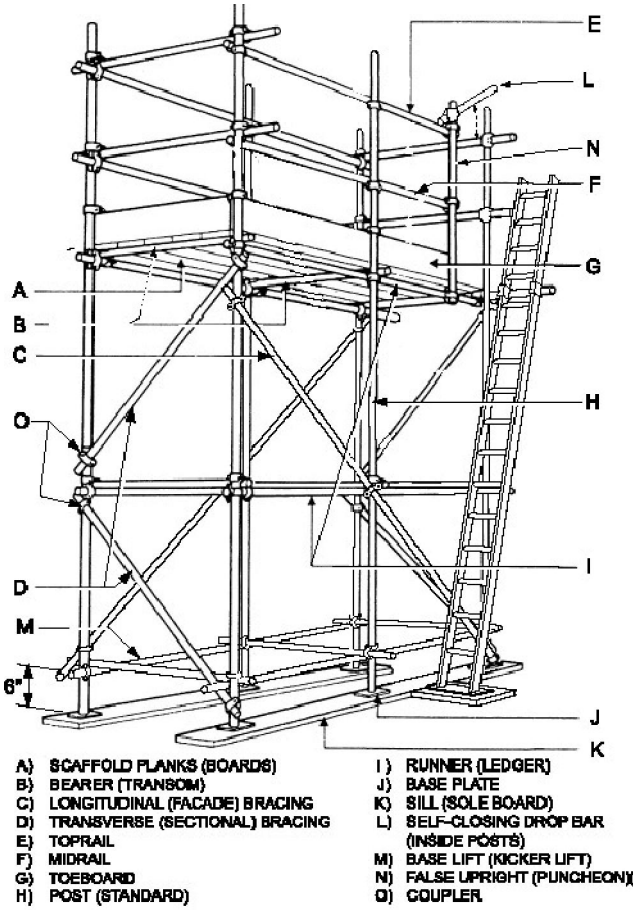

SCAFFOLD TERMINOLOGY

Eligibility and Experience of Person

Activity	Responsibility	Requirements
Scaffold Certification & Acceptance	The Person Authorized by Crop Sustain Ventures PVT.LTD	Trained and validated for the subject matter. (Only Mechanical & Civil Engineer)
Scaffold Supervision & Inspection	Supervisor of Scaffolding Contractor	Diploma Mechanical/Civil engineer with 2 years relevant field experience in a refinery / petrochemical / fertilizer / chemical plant. Trained and validated for the subject matter. Minimum age should be 21 years.
	Contractor Scaffolding Inspector	Experience and Qualification should match Crop Sustain Ventures PVT.LTD Work order i.e. BE Mechanical/Civil engineer with 5years relevant field experience or Diploma Mechanical engineer with 8 years relevant experience in inspecting, supervising, certifying the scaffolding jobs in refinery/ petrochemical/ fertilizer/ chemical plant.
Scaffolding erection, modification and dismantling	Scaffolders	Minimum 3year of experience in erection and dismantling of scaffolding as per Work Order. Minimum age 21 years, Maximum Age -45 Years.
	Scaffolding Helper	Literate with relevant site experience of 6 months. Minimum age 21 years, Maximum Age -55 Years.

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Selection of Type and Design of Scaffold

Type of Scaffold	Scaffold loading per m^2	Maximum number ofworking platforms	Maximum Bay Length (spacing between Standards)
Very light duty independent	75 kg	1 working platform	2.7 m
Light duty independent	150 kg	2 working platforms	2.4 m
General purpose independent	200 kg	2 working platforms and 1 at very light duty	2.1 m
Heavy duty independent	250 kg	2 working platforms and 1at very light duty	2.0 m
	300 kg	'-do-	1.8 m
Special purpose		To be stated after risk assessment	

Inspection of Scaffolding Material

Contractor Agency shall ensure that scaffolding material such as tubular pipes, planks, clamps, toe guard, guard rails etc. shall be inspected annually through authorized third party and report should be vetted by third party inspector, so that they confirm the minimum desirable strength and free from defects.

The scaffolding material (pipes & planks) shall be painted with the colour coding bend with 6'' width at both ends as mentioned below for consecutive year after every inspection.

Year of Inspection	Colour Code
2019	Green
2020	Blue
2021	Yellow
2022	Green
2023	Blue
Rejected	Red

Scaffolding Hazards

a) Slipping of unsecured ladders.
b) Use of unsuitable scaffold or damaged materials.
c) Inadequately supported / secured planks.
d) Inadequate or insufficient platform widths.
e) Omission of guard rails or toe rails.
f) Failure to properly secure the scaffold to the building, adjacent structure or to brace it adequately.
g) Fall from height / elevation - person or material.
h) Struck by – falling tools / debris or other material.
i) Electrocution from nearby overhead power line.
j) Overloading the scaffold platforms, etc. lead to collapse of structure.
k) Collapse of structure due to natural calamities like heavy rain, cyclone etc.

SAFE ERECTION OF SCAFFOLD

Administrative Control:

- Scaffolding shall be erected by competent riggers/scaffolders under supervision of experienced & competent supervisor only. They should be trained to use PFAS – person fall arrestor system - anchorage of lanyard of full body harness. Person age more than 45 years should not allow for scaffolding erection / removal job.
- During the erection stage of scaffolding, Scaffolding Tag with the wording "DO NOT USE SCAFFOLD" Annexure - 2A shall be fixed to the scaffolding at all access points / prominent locations.

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- After erection, but before use of scaffolding, the erected scaffolding shall be inspected as per the checklist mentioned in Annexure - 2 and certified by the person authorized by Crop Sustain Ventures PVT.LTD - Mechanical/ Civil Head.
- Crop Sustain Ventures PVT.LTD-Mechanical /Civil Head shall maintain a list of such authorized persons in Annexure – 3
- "SCAFFOLDING READY FOR USE" shall be provided with a filled checklist (Annexure - 2) on back side with signature of authorized person as shown in Annexure - 2B.
- Suitable nos. of tags to be provided at a prominent location at the access points as per size of scaffolding.
- Once erected the scaffolding shall be inspected every week or after any alteration/ modification by an authorized person and he shall sign on the Scaffolding Tag attached to the scaffold.
- All scaffolding materials to be checked visually for any defects before starting of scaffolding erection by authorized person (Civil or Mechanical Engineer).
- After any adverse weather condition or modification viz. high wind speed, heavy rain, cyclone etc. and checklist shall be revalidated by authorized person.
- When the completed scaffolding is handed over for use, it is the responsibility of user to ensure its correct and safe use.
- In the event of any doubt concerning the integrity of particular scaffolding, "DO NOT USE SCAFFOLD" (Annexure - 2A) tag to be fixed immediately by working / operation person and same shall be communicated to concern engineering In charge for immediate rectification.

Safety Technical Aspects:

- Scaffolding erection shall be done from bottom to top. Surrounding area barricading to be done prior to start the erection / removal of scaffolding.
- For critical activities, job specific scaffolding sketch shall be prepared for basic understanding to executing agency. Sketch should be reviewed and approved by authorized person and attached with relevant work permit. e.g. LPG Sphere, Tank High elevation job.
- Place the base plate (size: 6x6 inches, thickness: 6 mm) as per the design criteria maintain the spacing.
- The footing of scaffold shall be placed on levelled & sound ground capable enough of carrying maximum intended load without settling or displacement.
- Don't use concrete blocks, barrels, boxes, loose bricks etc. for support of scaffolds.
- During scaffolding erection / removal all scaffolding material shall be lifted by rope (suitable size without knots) or pulley arrangement / mechanical or pneumatic hoist and (If the scaffolding is being erected / removed near or on the permanent platform, material should be tied with rope to avoid accidental fall / slippage of the same, which can lead to person injury or nearby property damage). Man chain or throwing of scaffolding material is strictly prohibited.
- During the erection of first horizontal level small pipes shall be used instead of clamp for ascending and descending.
- After reaching to the first horizontal level, place one temporary bracing on one side of scaffold before proceeding further.
- The height of scaffold should not be more than four times of its minimum base dimension unless guy ropes, ties or braces are used or properly supported laterally. It is applicable if fixed structure support is not available. Bracing shall be fitted up to full height of scaffold.
- Ensure that first horizontal member on either side of scaffold is at 2 meter height from ground.
- Platform shall be made at least 46 cm fastened securely. Pipes & Planks shall not extend beyond 6" (150 mm). If not possible to maintain 150 mm, the extended part should be highlighted with barricading tap.
- Joints in standards should not occur in the same lift. Joints should be arranged so that they occur as near as possible to a ledger. All standards shall be vertical. Ledgers shall be securely fixed to standards and shall be

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horizontal. Joints in ledgers should be staggered, i.e. joints in adjacent ledgers should not occur in the same bay).

- Planks shall be laid with no openings more than 1 inch (25 mm) between adjacent guards or scaffold member. Planks should be tied with binding wire to avoid misalignment.
- Overlapping of two platforms should be done at least 12 inches over plank support.
- Guardrails and toe guards shall be fitted to the inside of standards to prevent outward movement. If guardrails and toe guards are removed for the movement of materials, they shall be restored as soon as practicable (ex. heat exchanger jobs).
- Use of monkey ladder to access working platforms on scaffolds is not recommended, as it will obstruct free entry through the ladder cage.
- Provide guard rail (1200 mm), mid rail (600 mm) & Toe guard (100 mm).on all open sides and end of the platform above 2 m height. Toe guards are generally applicable to working platform and not for landing platform. In case of provision of toe rail, at least two pipes should be provided at toe rail.
- Where scaffoldings are erected above walkways or work areas, the space between toe board and railing should be screened (e.g. Safety net, Metal sheets).
- Scaffold should be vertical & checked with plumb. So that bracing will fit without forcing.
- Scaffold shall be braced at all four sides.
- Always keep 3 meter distance from overhead high tension line and get counter sign by relevant electrical engineer on the work sheet / permit.
- Safe & convenient means of access to be provided: portable ladder, fixed ladder, ramp or runway. It is the duty of supervisor to provide safe access and safe work location through the use of permanent platforms, temporary platforms and lifelines.
- Climbing on scaffolding braces, runners etc. is not permitted except as required by scaffolder during scaffolding erection, alteration and dismantling.
- Scaffold having more than 10 m height shall be secured with fixed structure for stability at first & then at every 8 m, wherever provision of fixed structure.
- No worker should be expected to expose himself to an unprotected fall while getting to the work location or while working.
- Ladder shall be installed immediately after completion of second horizontal plane or 6 mtr.
- Ladder shall extend at least 3 rungs from the platform and bottom rung shall not more than 24 inches above from ground level. Ladder fixing to be done at 75^0 angle to the scaffolding and only if required as per site situation can be fixed up to 90^0.
- Ladder shall be connected with the ledger through ladder clamps.
- Rope grab to be installed for safe ascending and descending.
- Extension ladders shall not be used in scaffolding.
- Scaffolding which spread to 20 meter or more should have two accesses preferably opposite site.
- Scaffolding shall be erected with a factor of safety not less than 4.
- The height of the scaffolding should not be more than four times its minimum base dimension, unless guys, ties and braced are used.
- Use of full body harness with double lanyard with scaffolding hook by all scaffolders after completing first horizontal plane.
- Vertical member shall be connected with horizontal member by using fix clamp (right angle) only.
- Only bracing can be connected with vertical member by using swivel clamp at ground end. Other end of bracing shall also be connected with horizontal member by using fix clamp as far as possible.
- Keep distance of at least 150 mm between high temp pipelines or equipment and scaffolding.
- While erection or dismantling of scaffold the spanner shall be used with proper string in hand so that it will not fell down.

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- Accumulation of water nearby scaffolding area to be avoided.
- In case of very high scaffolding, proper mean of communication between person at ground level and at top shall be ensured.
- Suspended scaffolding shall be prepared as per job requirement. Maximum person allowed for working on suspended scaffolding should be identified and mentioned in the TBRA / work permit. Separate TBRA covering hazards of suspended scaffolding shall be jointly prepared with concern person.
- Scaffolding erection at all utilities pipe racks should be prepared with planks at kicker lift platform.

V. SAFETY IN USE OF SCAFFOLD

Administrative Control:

- Display the copy of Permit at work location.
- Ensure adequate and competent supervision during the course of activity.
- After completion of work close the work permit and submit to the area owner for record.

Safety Aspects:

- Before using the scaffold check the inspection tag marked on it and ensures that it is safe for use.
- Before climbing up check that it is not under digged, all bracing members are in place.
- Wear hand gloves while climbing the ladder.
- Fall protection is not needed when climbing up or down ladders less than 20 feet or 6.1 meters, using three points of contact.
- Use a ladder climbing safety device, such as an inertial reel fall arrestor/rope grab, when climbing up or down uncaged ladders 20 feet or 6.1 meters or longer.
- When scaffold certified with proper toe boards and guardrails on platform it forms a protective environment and as such additional personal fall protection is not required. However this would be required if the person work projecting his body outside of the protective environment.
- While using scaffolds that have been purposefully modified by removing elements such as guardrails, toe boards etc. to allow a specific task to be performed, such as removal of equipment (e.g. heat exchanger bundle pulling) personal fall protection shall be used as they no longer form a protective environment.
- Access to these modified scaffolds should be minimized and is limited only to those people involved in the task.
- Appropriate fall protection shall be used when specify in task based risk assessment for specific jobs.
- Wear Full Body Harness with double lanyard and with Energy Absorber and should have validity for use as defined by Crop Sustain Ventures PVT.LTD
- No loose material shall be left on the platform. Place the tools in tool box & other items in basket.
- Don’t climb up on the rails of scaffold to over reach job location.
- Take care of overhead electric lines always keep your self 3 meter away from the same. In such case clearance from electrical engineer is must and get counter signature on work permit prior
- to begin its use.
- Don’t connect return / earthing cable of welding machine with the scaffold.
- Don’t overload scaffold. Working platform when fully loaded shall not deflect more than 1 /60 of the span.
- Provide barricading so that it will not be hit & run by any vehicle or equipment & also will be free from man movement.
- Appropriate fall protection shall be ensured for suspended scaffolding.

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SAFE DISMANTLING OF SCAFFOLD

Administrative Control:

- Display the copy of permit at work location and Scaffolding Tag with the wording "DO NOT USE SCAFFOLD" (Annexure- 2A) should be fixed to the scaffolding at all access points.
- Barricade the area of work and restrict the entry of unwanted person.
- Ensure that scaffolding to be dismantled by the scaffolders in presence of competent / experienced supervisor.
- Immediately after completion of work, supervisor has to inform concern authorize person for dismantling / removal of scaffolding. After completion of work close the work permit and

submit to the area owner for record.

Safety Technical Aspects:

- Scaffolding removal shall be from top to bottom plane wise.
- First remove bracing and than remove all horizontal members in one plane.
- After reaching to second last horizontal plane, first install bracing of 3 m for ground level plane & then only remove the horizontal members at second level.
- Loose scaffolding member shall be lowered down by rope & not by using man chain or throwing. To avoid accidental slippage of rope tied on the lowering member from height, keep at least one scaffolding clamp on each member (ledger / standard / bracing) while dismantling.
- Loose member shall be segregated and stacked properly. Ensure stacked material do not create trip or obstruction hazards to emergency services.
- Removal of ladder may be done after only reaching to the second last horizontal plane from ground level.
- While erection or dismantling of scaffold the spanner shall be used with proper string tied with full body harness and hold in hand so that it will not fell down.

Storage, Transportation / Handling of Scaffolding Material

- All scaffolding material shall be stored at designated location to protect them from adverse environment conditions such as corrosion, weather.
- Storage racks/ Locations/ areas shall be clearly identified.
- Storage facility of scaffold material shall be properly constructed for its stability and load bearing capability.
- Steel pipes and scaffolding platform Plank shall be stacked horizontally according to length. Fittings, Couplers shall be stored in separate bins.
- Defective material shall be painted with red colour and removed from site.
- Make sure that scaffold pipe shifting done in vehicle of appropriate length.
- Special safety care to be taken while shifting or lifting pipes manually.

Use of Safety Nets:

- If Proper area barricading below the working area is not possible, safety net shall be provided and "Work in Progress" boards shall be displayed.
- Whenever it is required to carry out work at height where proper approach cannot be provided, safety net must be used.
- PP rope of all safety net systems shall meet the requirements of Indian Standard (IS: 5175).
- Nets shall be made with a square or diamond mesh and the length of the mesh side shall be not greater than 10 cm.
- Safety nets shall be installed as close as possible to the working level but in no case more than duty height of safety net.
- Material, equipment and other items that fall into the net shall be promptly removed.
- A continuous length of net, having no joins, shall be used to cover the span between supports.

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- When in use, the net shall have a sag at the centre of not less than one-fifth and preferably not more than one-fourth of the length of the shorter side.

PERIODIC TEST AND INSPECTION

- Nets in use should be inspected weekly by a competent person. Immediately after any incident that may have affected the strength of the net, the net should be carefully examined.
- Safety nets are shall be inspected before use and then daily for wear or damage caused by falling materials.
- Safety net installation shall be inspected by the concerned maintenance engineer.

Scaffolding Request form

Scaffolding Request:

Date:		Time:	
Scaffolding Request to (Name of contractor)			
Proposed load capacity of scaffolding (in Kg/m^2)			
Reference work permit No. & date			
Area of scaffolding			
Specific location of scaffolding			
Purpose of scaffolding to be prepared			
Requested by (Authorized Crop Sustain Ventures PVT.LTD Energy Employee)		**Erector (Contractor Supervisor)**	
Name:	Sign:	Name:	Sign:

Scaffolding Fitness Certificate

No	Check Points	Status	
		Yes	No
1.	Has the scaffolding preparation area barricaded during erection/usage/dismantling?		
2.	Is scaffolding material (each components of scaffolding structure) being used is in good condition and is as per color code of current year?		
3.	Is footing of scaffold with metal base plate (6"x6"x6mm) placed on leveled & sound ground?		
4.	Is the scaffolding in plumb and level? The bay length maintained as per the max. Intended load?		
5.	Are the scaffolding erected as per the load duty requested?		
6.	Standards / Vertical or Post or Upright of scaffolding are securely braced to prevent swaying / displacement?		
7.	Is first Ledger / Horizontal / Runner of scaffolding placed at 2 meters from ground to prevent head injury to persons moving underneath?		
8.	Are plank or horizontal beam protruded <6"?		
9.	Are every work platform fitted with handrail (1200mm), knee rail (600mm) and a toe rail (150 mm) high to all open sides?		
10.	Is approach ladder placed vertically and extended at least 3 rungs / 1050mm from the scaffolding platform?		
11.	Is free standing scaffolding towers protected from tipping by guying or other means?		
12.	Are the planks placed in order without undue gaps and secured properly?		
13.	Is scaffold >10meters height secured with fixed structure at first & than at every 8 meters?		
14.	Are landing platforms provided for access ladders more than 9meters height?		
15.	Is the scaffolding erected with safe distances from HT wires cables, instrument tubing, small bore piping, and delicate instruments?		
16.	Are relevant display tag provided to the scaffolding Green (Ready to use) / Red (Under erection/ Unsafe to use) as applicable?		
17.	Measurement: Length (_____m) x Width (_____m) x Height (_____m) x Nos. (____) =_____m^3		

Date	Time	Reviewed and Verified by (Authorized Crop Sustain Ventures PVT.LTD Energy Limited Employee)	
		Name:	Sign:

*Note: 1. "NO" for any of the above condition shall be considered as scaffolding "Unsafe to use".

2. Contractor & Authorized Crop Sustain Ventures PVT.LTD Energy Employee shall carry out further periodic inspections every seven days.

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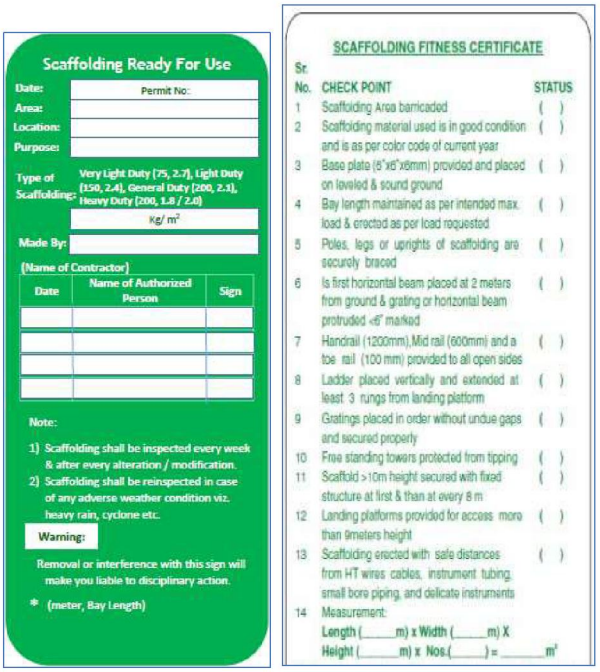
Scaffolding Tag W/O Inspection Card
NOT SAFE FOR USE

SAFE FOR USE



Scaffolding Ready For Use

Date: Permit No:
Area:
Location:
Purpose:

Type of Scaffolding: Very Light Duty (75, 2.7), Light Duty (150, 2.4), General Duty (200, 2.1), Heavy Duty (200, 1.8 / 2.0)
Kg/ m²

Made By:
(Name of Contractor)

Date	Name of Authorized Person	Sign

Note:
1) Scaffolding shall be inspected every week & after every alteration / modification.
2) Scaffolding shall be reinspected in case of any adverse weather condition viz. heavy rain, cyclone etc.

Warning:
Removal or interference with this sign will make you liable to disciplinary action.

* (meter, Bay Length)

SCAFFOLDING FITNESS CERTIFICATE

Sr. No.	CHECK POINT	STATUS
1	Scaffolding Area barricaded	( )
2	Scaffolding material used is in good condition and is as per color code of current year	( )
3	Base plate (6"x6"x6mm) provided and placed on leveled & sound ground	( )
4	Bay length maintained as per intended max. load & erected as per load requested	( )
5	Poles, legs or uprights of scaffolding are securely braced	( )
6	Is first horizontal beam placed at 2 meters from ground & grating or horizontal beam protruded <6" marked	( )
7	Handrail (1200mm), Mid rail (600mm) and a toe rail (100 mm) provided to all open sides	( )
8	Ladder placed vertically and extended at least 3 rungs from landing platform	( )
9	Gratings placed in order without undue gaps and secured properly	( )
10	Free standing towers protected from tipping	( )
11	Scaffold >10m height secured with fixed structure at first & than at every 8 m	( )
12	Landing platforms provided for access more than 9meters height	( )
13	Scaffolding erected with safe distances from HT wires cables, instrument tubing, small bore piping, and delicate instruments	( )
14	Measurement: Length (_____m) x Width (_____m) X Height (_____m) x Nos.(_____) = _____ m³	

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Case Study- Scaffolding Erection and Dismantling activities for Stack

Sub activity	Hazards identified	Consequences	Control measures required
Scaffolding Scaffolding Erection and Dismantling Lifting & Shifting of Scaffolding Material	Lack of awareness, Fall of material, Scaffolding collapse Omission guard rail and toe rail	Fall injury, hit injury by moving objects, cut injury.	• Ensure base plate and bracing is provided for stability of scaffolding. • Ensure application of mandatory as well as job for use specific PPE's. • Ensure material should be lowering and hoisting by rope and pulley. • Ensure no any loose materials should be kept on scaffold. • Ensure that return path is directly connected to the job. • Scaffolding pipes will be tied /secured at two locations before lift by rope and pulley. • Spanner will be kept tied with Stringer or rope. • Scaffolding will be prepared as per sequence. • Double lanyard safety harness shall be provided, used and anchoring the at height. • While using ladder for small job proper anchorage arrangement will be provided • Should be provided at toe rail. • Provide guard rail (1200mm), mid rail(600mm) Toe guard (100mm) on all open sides and end of the platform above 2m height. Toe guards are
			generally applicable to working platform and not for landing platform. in case of provision of toe rail, at least two pipes • Use 6X6inch and 6mm thickness base plat. • During erection of scaffolding tag with the wording "DO NOT USE SCAFFOLD" • Overlapping of two platforms/ grating should be done at least 12 inch over grating supports. • The footing of scaffolding shall be placed on leveled & sound ground, capable enough of carrying maximum intended load without settling of displacement. • Cross bracing area provided for all side of scaffolding structure.
	Slipping of unsecured ladders		• Ladder shall be secured properly with ladder clamps. • Visual inspection of ladder shall be done prior to use. • Ladder shall be as per the required height, placed vertically. • Maintain three point contacts. • Don't carry any material in hands while ascending/descending scaffold. • Ladder shall be always place on platform grating. • Follow all technical aspects and safety precautions as per procedure of scaffold.
	Inadequately supported / secured gratings/ Inadequate or		• Gratings placed in order without undue gaps and secured properly with clamps/binding wires. The same shall be visually inspected prior to use. • Sufficient gratings should be used with barrier. • Sufficient space shall be provided in working platform.
			• Material should not be stacked more than the load of scaffold. • Scaffolding materials shall be color coded as per procedure and certified with third party inspection certifications
	Fall of person form the height	Fall injury, Fatal injury to personnel	• Ensure use of full body harness and its anchoring properly. Visual inspection of full body harness shall be done prior to use. • Ensure proper access and egress to be provided on scaffold. • Ensure adequate railing(top rail 1200mm, mid rail 600mm and toe guard 100mm to 150mm) is provided on working platform. • Ensure that return path is directly connected to the job. • No workers are allowed to stand under suspended load. • All the working personnel shall be free from height phobia. • Training shall be given to working personnel daily prior to job. • Personnel shall not be allowed to work at the inside bottom of Scaffolding while the work is in progress. • No worker should be expected to expose himself to an unprotected fall while getting to the work location or while working.

Prepared by:

Name: _____ Designation : _____ Sign: _____ Date: _____

Name: _____ Designation : _____ Sign: _____ Date: _____

Reviewed by:

Name: _____ Designation: Area manager/ Asst. AM Sign: _____ Date: _____

VI. CONCLUSION

From the research, the degree of safety awareness among workers and management team are relatively low. Thus, management team and workers should observe the highlighted scaffolding safety aspect as mentioned in chapter 4 in accomplishing a project. Indirectly this project contributes method in enhancing the safety of scaffolding and reducing accident related to scaffolding. Consequently scaffolds may become a safe equipment to work on if only the aspect of safety is considered as priority than money in order to provide the safety needs in the construction site such as training program, personal protective equipment by the construction firms. If we manage to prevent unsafe act the quality of our local construction will be increased. Thus, this project may help to create safety scaffolding environment in construction sites so that it will decrease the number of accidents on sites and provide maximum safety to workers.

Poor management safety in construction sites is the contributor of death and injuries in construction sites. All parties such as government agencies, construction industry management, employer and also construction workers had to realized that scaffolding safety is one of the importance parts to be focused on, preventing is more preferable than to cure.

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Based on the case studies analysis the cause of increasing number of injuries and death cases in construction industry within working with scaffolding because of the employer neglecting to provide complete personal fall protection equipment for workers and human weakness. Some of the employer failure to comply an OSHA standard regulation of manufactures guidance regarding proper assembly, dismantle and use of scaffolding.

The present levels of awareness between the employer and workers in construction industry have improved from year to year. Even though some of them have still not realized the importance of scaffolding factor safety in construction sites. It is to reduce the death and injuries cases in construction industry. The government agencies have implemented a lot of program to improve the level awareness all the parties in construction industry at the same time to improve professional image.

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