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A Concept for Development, Safe Erection and Use of Scaffolding for High Rise Buildings

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Abstract- ***The objective of the paper is to study different parameters involve in building a Scaffolding system for High-Rise Structures for supporting formworks, working platform and passageway for material logistics etc. The study also includes analysis of design guidelines for safe erection of scaffolding system. Scaffolding is the structure used or intended to use for supporting framework, swinging stage, suspended stage or protection of workers engaged in or in connection with construction work, for the purpose of carrying out that work or for the support of material transportation from one level to other or connection with any such work. Scaffolding system is defined as the planning for the design, erection and the inspection of the use and the dismantling of any scaffolding. By law, worker must have safe working environment. And most construction work involves working at heights which cannot be safely or easily reached from the ground or part of the building. The scaffolding design criteria consider the strength; stability; rigidity of the supporting structure and the safety of persons engaged in the erection, alteration and dismantling of the scaffold. When any material is transferred on or to a scaffold it shall be moved or deposited without imposing any violent shock. Scaffold system shall be properly maintained and every part shall be kept so fixed, secured or placed in a position as to prevent, as far as is practicable, accidental displacement. Thus, it must be designed for the most adverse combination of dead loads, live loads, impact loads and environmental loads that can reasonably be expected during the service life of scaffolding. The detail report considers design criteria given by various designing standards.***

Keywords: Scaffolding, Formwork, Strength, Design, Safety

I. INTRODUCTION

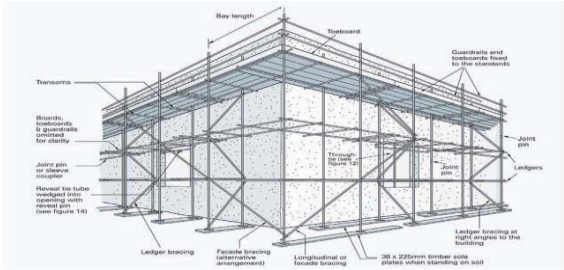
Scaffolds are temporary structures commonly used in construction to support various types of loads. The vertical loads on scaffold can be from labourers, construction equipment, formworks, and construction materials. Commonly, scaffolds must also be designed to withstand lateral loads, including wind loads, impact loads. Depending on their use, scaffolds may be categorised as access scaffolds or support scaffolds. Access scaffolds are used to support light to moderate loads from labourers, small construction material and equipment for safe working space. They are usually attached to buildings with ties and only one bay wide. Support scaffolds, also sometimes called falsework, are subjected to heavy loads, for example, concrete weight in the formwork. An example of a support scaffold system is shown in Figure. Support scaffolds normally consist of standards (vertical members), ledgers (horizontal members), and braces. The scaffold standards are connected to each other to create a lift via couplers, also known as spigot joints. In order to connect ledgers to standards, wedge-type or Cuplock joints are usually preferred for the connection because no bolting or welding is required; though, in some systems manually adjusted pin-jointed couplers are still being used. The connections for diagonal brace members are usually made of hooks for easy assembling.

II. RISK INVOLVED IN SCAFFOLDING SYSTEM

Hazards associated with work involving the erection, alteration and/or dismantling of scaffold includes:

1. Formwork collapse (before, during and after placement of concrete)
2. Improper Design of Scaffolding System
3. Inadequate safety measures
4. slips and trips
5. falling objects
6. Human errors
7. Impact Load from Loading , Unloading of material on formwork
8. Inadequate space for working on heights

III. VARIOUS COMPONENTS OF SCAFFOLDING SYSTEM



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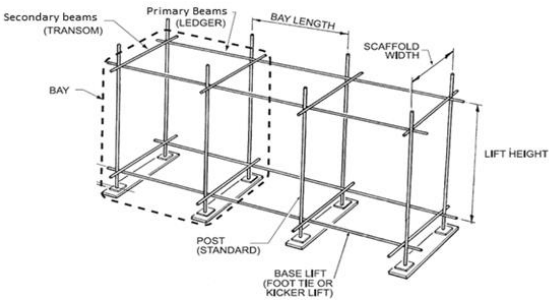

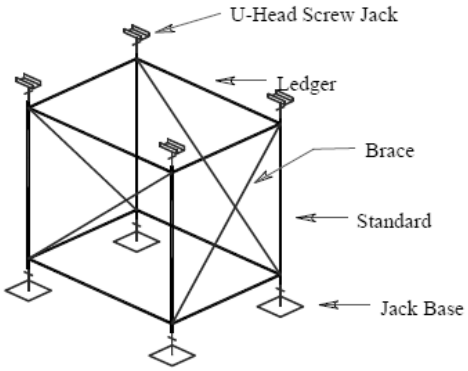

Jack Base plate
Metal plate with a spigot for distributing the load from a standard, raker or other load bearing member

Bay length
Distance between the centres of two adjacent standards measured horizontally

Brace
Tube placed diagonally with respect to the vertical or horizontal members of a scaffold and fixed to them to afford stability

Coupler
Component used to fix scaffold tubes together

Joist or transom
horizontal or sloping beam, e.g. the horizontal memberss that carry decking for a suspended concrete slab

Ledger
horizontal beam, e.g. the horizontal members that carry decking for a suspended concrete slab, connected to standards

Spigot pin
pin placed transversely through the spigot and the scaffold tube or frame to prevent the two from coming apart

Standard
Vertical or near vertical scaffold tube

Toe board
Upstand at the edge of a platform intended to prevent materials or operatives' feet from slipping off the platform

U-Head Screw Jack
Supporting component for ledgers

IV. Design Principle For Scaffolding

- In a high rise structure it is always necessary to have ease in mobility of materials, safety features and workable space after certain height.
- It is not always possible to erect scaffolding from ground floor.
- When any material is transferred on or to a scaffold it shall be moved or deposited without imposing any violent shock.
- All scaffolds shall be properly maintained and every part shall be kept so fixed, secured or placed in a position as to prevent, as far as is practicable, accidental displacement.

The design of the scaffold shall take into account the following:

(a) The strength, stability and rigidity of the supporting structure;

(b) The loadings normally associated with scaffolding;

(c) The safety of persons engaged in the using, erection, alteration and dismantling of the scaffold;

(d) The suitability of material of scaffolding system;

(e) The working condition with respect to environment, nature of work, period of scaffolding system etc.

Material
Different natural materials such as timber and bamboo have been used in the past and are still being used to construct scaffolds. In some parts, cold-formed circular hollow steel sections are mainly used as members of scaffold system due to their high strength and reusability. The steel tubes used for standards and ledgers commonly have an outside diameter between 42 mm to 48 mm with thickness of approximately 3 mm. As for bracing, various types of steel sections are currently used in scaffold construction.

Loadings to be considered during design of Scaffolding

Concrete Load
The load of concrete is considered as per the pouring rate given as per the design standards. The density of fresh concrete is taken as, 26 kN/m3.

Dead load
The dead load (DL) shall include the self-weight of the scaffold structure and components including working platforms, catch platforms, access platforms, stairways, ladders, screens, sheeting, platform brackets, suspension ropes, secondary ropes, traversing ropes, tie assemblies, scaffolding hoists, electrical cables and any other attachments, where appropriate.

Live loads
The live load (LL) shall include the following:

(a) The weight of persons;

(b) The weight of materials and debris;

(c) The weight of tools and equipment;

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Impact Loads

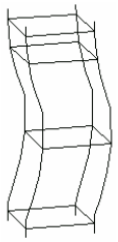
The loads that occur during loading , unloading of material, due to falling objects, pouring of concrete etc.

Environmental load

Considering the wind coefficient and wind speed, forces should calculate for high rise scaffolding system.

Bracing System

Bracings are important in terms of increasing the stability and the load carrying capacity of scaffold systems.



Failure pattern of Scaffolding w/o bracings

V. RESULTS AND DISCUSSION

The safety and precautionary measures are to be accounted and scaffold register to be maintained so as to avoid accidents and life risks. It is always recommended to keep records of various scaffold system as to maintain a risk free construction activity.

SAMPLE SCAFFOLD REGISTER			
Project Name:		Location:	
Address:			
Main Contractor:		Contact:	
Reason for Scaffold:			
Scaffold Erector:			Phone:
Subcontractors to use Scaffold:			
Height:	Length:	No of Platforms:	
Duty:	Limitations:		
Comments:			
INSPECTION RECORD			
Date:	Name of Inspector:	Signature:	Comments:

VI. CONCLUSION

This paper briefly introduces findings of study of development and emphasis on the design, safety performance and economical effectiveness of scaffolding in high rise buildings. To ensure safety during construction, support scaffolds should be monitored by their axial forces and displacements of the standards especially during concrete placement, and inspected if bracings are applied correctly and adequately. In case of access scaffolds, sufficient ties to permanent structure must be provided to prevent excessive lateral movement. To consider both safety and economic factors synthetically, it is found that designer, contractors and laborers should be encouraged to use properly designed scaffolding for safer construction.

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