

## Formwork

Formwork is a temporary structure used to support wet concrete until it hardens and gains sufficient strength. Shoring and bracing are critical components that support the forms and ensure they can withstand the weight of the concrete, reinforcing steel, and live loads from workers and equipment. Formwork operations involve three key stages:

- **Assembly and Erection:** Building and setting up the formwork structure.
- **Concrete Placement:** Pouring and shaping the concrete within the formwork.
- **Stripping and Dismantling:** Removing the formwork after the concrete has cured.

Each stage requires careful planning, knowledge, and skill from both supervisors and workers. Design and planning are typically supervisory functions and may require the involvement of a qualified engineer, especially for large projects. However, smaller construction and renovation jobs may involve on-site design by workers.

### Design and Safety Requirements

Formwork, falsework, and re-shoring must be designed, constructed, supported, and braced to withstand all expected loads and forces. In Saudi Arabia, these systems must comply with Saudi Arabia relevant Regulations and, where applicable, the specific standards of clients such as Saudi Electricity Company (SEC) and Saudi Aramco (SA).

#### Key requirements include:

- **Design by an Engineer:** Formwork systems must be designed by a qualified engineer, and design drawings must be available on-site while the system is in use.
- **Inspection:** Formwork must be inspected before concrete placement by an engineer or a competent worker designated in writing by an engineer.
- **Compliance with Design:** The person conducting the inspection must confirm in writing that the system was constructed according to the design drawings and that all required tests have been performed.

### Design Drawing Requirements

Each design drawing for formwork, falsework, or re-shoring must include the following details:

- **Identification of Components:** For manufactured systems, identify all components.
- **Specifications of Non-Manufactured Components:** For non-manufactured systems, specify the size, grade, and other relevant details.
- **Design Loads:** Show the design loads for the structure and detail the bracing and external ties required to support these loads.
- **Attachment Points:** Indicate attachment points for rigging and hoisting if the structure is a unitized modular formwork or falsework system intended to be lifted or moved as a unit.
- **Assembly Instructions:** Provide assembly instructions from the manufacturer or engineer.

### Working Loads

Working loads must adhere to the following guidelines:

- **System Capacity:** Loads must not exceed the capacity for which the system was designed and constructed.
- **Component Capacity:** Loads must not exceed the allowable load of any individual structural component.
- **Stability:** Loads must not cause uplift, sliding, overturning, or lateral displacement of the system.
- **Engineer's Approval:** Working loads must be established by an engineer and verified through testing of principal components under simulated loading conditions, with an appropriate safety factor applied.

### Removal of Formwork and Falsework

Formwork and falsework may only be removed if:

- The concrete can support itself and any additional loads.
- The concrete and structure are adequately re-shored to ensure stability.

## Re-Shoring Requirements

Re-shoring must be constructed according to an engineer's design drawings. Key considerations include:

- **Bracing:** If single post shores are arranged more than one tier high, each junction must be braced against a fixed support in at least two directions to prevent lateral movement.
- **Footings:** Falsework and re-shoring must have sound and rigid footings capable of carrying the maximum load without settlement or deformation. Footings must also be protected from damage caused by frost heave.

## NCC T&D Project Leaders Key Responsibilities

NCC T&D Project Leaders must ensure the following:

- **Design Compliance:** Verify that all formwork systems are designed by a qualified engineer and comply with Saudi Arabian regulations and client-specific standards.
- **Inspections:** Ensure formwork systems are inspected before concrete placement by a competent person.
- **Training:** Provide workers with adequate training on formwork assembly, concrete placement, and dismantling procedures.
- **Documentation:** Maintain design drawings, inspection records, and test results on-site while the formwork is in use.
- **Safety Measures:** Implement additional safety measures, such as regular inspections and real-time monitoring, to ensure compliance with formwork procedures.

## Worker Responsibilities

Workers involved in formwork operations must:

- **Follow Procedures:** Adhere to all safety protocols and assembly instructions provided by the engineer or supervisor.
- **Inspect Equipment:** Conduct pre-use inspections of formwork components and report any defects or damage.
- **Use PPE:** Wear appropriate personal protective equipment (PPE), including helmets, gloves, and safety harnesses.
- **Report Hazards:** Notify supervisors of any unsafe conditions or potential hazards.

## Additional Considerations for NCC T&D Projects

Given the high-risk nature of NCC T&D's operations, the following measures are recommended:

- **Pre-Work Planning:** Conduct pre-work hazard assessments to identify potential risks and ensure proper formwork design.
- **Regular Inspections:** Perform regular inspections of formwork systems during all stages of construction.
- **Rescue Preparedness:** Develop and implement rescue procedures for workers involved in formwork operations.
- **Training and Drills:** Conduct regular training sessions and drills to ensure workers are familiar with formwork safety procedures.

## Key Takeaways

- **Formwork Design:** Formwork systems must be designed by a qualified engineer and comply with Saudi Arabian regulations and client-specific standards.
- **Inspections:** Formwork must be inspected before concrete placement by a competent person.
- **Working Loads:** Loads must not exceed the system's design capacity or the allowable load of individual components.
- **Project Leader Duties:** NCC T&D Project Leaders are responsible for ensuring compliance with design, inspection, and safety requirements.
- **Worker Duties:** Workers must follow safety protocols, inspect equipment, and report hazards.

For more information, refer to NCC T&D's relevant IMS procedures or consult our HSE Department for expert guidance and training resources aligned with Saudi Arabian regulatory requirements.

