

Development of Mobile Tower Crane for Transmission Line Tower Erection

1. General Intent

Use of mobile tower crane for mechanisation of tower erection process can enhance the tower erection efficiency with increased safety to work at height. The mobile tower crane shall be used at sites in different geographical conditions and terrains. In a practical deployment, the mobile tower crane is seen to stand at the centre of the tower, flexibly attached to the tower, adopts an upper jacking scheme and has a reusable foundation/ hydraulic jack/ outrigger system. It lifts from both arms simultaneously to maintain balance and realizes the positioning of the tower material through the pitch and rotation of the single boom.

POWERGRID shall be procuring mobile tower crane with suitable safety features. The mobile tower crane design and mechanisms need to be carefully selected to fit the intended purpose.

Some of the features of the mobile tower crane are detailed below:

- a. Transmission line towers are relatively flexible structure and may not be suitable to bear the adhesion/ clamping forces generated by crane if installed on one side. Hence, tower crane should be placed in the centre of tower to maintain the load symmetry and may be attached to tower legs with flexible wire/ rope mechanism. Different design or mechanism is also acceptable if it fulfils the intended uses as described.
- b. Time required for assembly and disassembly of crane should be minimal (typically 1.5 to 2 hrs) so that erection process can be speeded up as crane shall be required to move from one location to another location within 1-2 days. As such, the crane should have high mobility design. Hence, foundation base if required, should be easy to install and should be reusable.
- c. To minimise the bending moment and consequently weight of crane, lifting mechanism and operator cabin preferably should be at ground or in the lower section of crane.

The specification covers the broad parameters of the crane. It is not the intent of the specification to specify the complete details of the crane for tower erection but to specify the functional requirement about performance, durability and testing. The crane assembly must be new, and in accordance with the purpose for which they are intended and should satisfactorily perform throughout the service life.

2.0 Scope of Work

The scope of work shall include design, development, testing, supply, demonstration and training of the complete crane system along with accessories and attachments. All accessories (hardware/control system) required for proper functioning of the system shall be supplied by the Bidder. Bidder should arrange for certification and registration of supplied crane and for this purpose, required documents as per regulatory norms shall be provided.

3.0 Technical details:

- a) The mobile tower crane should be mounted on a truck or crawler chassis for easy manoeuvrability to construction sites of tower across plain, uneven, rugged terrains including hilly and mountainous, snow cladded, desert and wetlands.
- b) The upper structure (weight-lifting arms) of the crane should be auto retractable along with height adjustment mechanism of main crane body. Crane should have flexible connection mechanism for attaching to the tower.
- c) The maximum cross-sectional width of the crane should not exceed the size of the tower upper cage/ body/ window.
- d) Crane should have the design such that it can be operated from ground and should be retracted back and moved from the location without removing tower members.
- e) For installation of hydraulic legs/jack/outrigger if required, ground space with reduced vertical space with height (upto 7m) is generally available up to size of 10m*10m (distance between tower legs at ground level) under the tower.

- f) Crane should have suitable folding mechanism for top lifting arms, so that crane can be retracted back towards ground vertically through top narrow cage/body/window of tower (size about 3m*3m).
- g) Crane should have electric/ hydraulic mechanisms capable of lifting tower sections and aid in erection of towers as well as movement of workforce with a minimum lifting capacity of 8tons.
- h) Should be equipped with automatic outriggers and levelling system for stability on uneven surfaces.
- i) Should be equipped with telescopic boom with jib extensions for flexibility in high-altitude assembly. Crane should have integrated lighting system for night operations and Integrated camera system for lifting supervision.
- j) Crane should have features for manual as well as remote control operation with wireless control for enhanced precision and safety.
- k) Crane should comply to following parameters:
 - i. **Lifting capacity:** 4 tons or more on each side (Total 8tons)
 - ii. **Lifting height:** 50m or more
 - iii. **Working range:** up to 15m or more on each side from centre (total 30 or more)
 - iv. **Wind resistant:** up to 55 km/h, ≤30 km/h (lifting), ≤55 km/h (idle)
 - v. **Mounting Location:** Centre of tower footprint
 - vi. **Application:** Transmission line tower erection (central-mounted, telescopic)
 - vii. **Telescopic Mast:** Modular steel/alloy section with electric/hydraulic system/similar
 - viii. **Operating mode:** Manual, Semi-automatic or Fully remote control
 - ix. **Erection Height:** Up to 50 meter
 - x. **Lifting Range:** Symmetrical from central mast-180° span per arm or more
 - xi. **Lifting speed:** Minimum 5m/min under full load (Adjustable)
 - xii. **Slewing Range:** 180° or more rotation or restricted by tower geometry
 - xiii. **Power source:** Diesel/ Petrol/ Hybrid/ Electric
 - xiv. **Stabilization:** Internal Locking within tower legs and outriggers if required
 - xv. **Mobility:** Modular transport (truck/ trailer mounted) with minimum speed of 30km/hr on ground or Crawler Mounted with speed of 2km/hr.
 - xvi. **Mast Section:** High-strength galvanized steel or structural aluminium or alloy
 - xvii. **Telescopic Mechanism:** Hydraulic jacking system with interlocks
 - xviii. **Winch system:** Winch with load monitoring
 - xix. **Safety locks:** Mechanical and hydraulic safety interlocks on mast and arm
 - xx. **Brakes:** Electro Magnetic Disc Type Brake or conical rotor shoe.
 - xxi. **Control Panel:** PLC-based logic with remote control option, Weatherproof remote or cabin based
 - xxii. **Sensors:** Load Sensors, Tilt sensors, wind speed sensor, height encoder
 - xxiii. **Display:** Real time display of load, height, wind speed, fault code etc.
 - xxiv. **Operating temperature:** 0°C to +50°C
 - xxv. **Humidity:** Up to 90%RH (non-Condensing)
 - xxvi. **Corrosion Resistance:** minimum C3-class corrosion protection
 - xxvii. **Safety:** Load moment limiter and overload protection, Emergency stop, Anti-drop safety latch on lifting arm, Auto lock mast in case of power loss, Wind speed monitoring and auto lock at thresholds >55km/h, Hooter with adjustable setting. Overall cranes should meet the applicable safety norms.
 - xxviii. **Compliance:** IS 4137 / ISO 4306 for crane safety and definitions and IEC 60204-32: Electrical Equipment of Machines or other relevant standard

4. Development Activities

Being a development activity associated with the crane following should be provided as development validation.

1. Actual 3D model of crane used for testing and evaluation should be provided in format of AutoCAD or equivalent 3D modelling software.
2. Details of the structural materials and wire rope with test report.
3. Stress/Strain/Bending moment/Trusses/Load distribution simulation study results along with actual 3D model representing boundary condition, materials properties and stress/load result. Model should be compatible to open in any FEM (Finite Element

Method) /BEM (Boundary element Method) analysis software to verify and showcase the results.

4. Load deflection analysis/ test report.

5. Drawing and complete set of test report of crane as per applicable IS.

6. Monthly progress report along with applicable test report on development of crane should be submitted for review.

Regulatory Norms: Supplied mobile tower crane should fulfil applicable regulatory norms like certification if applicable.

Testing: Inspection and testing: In line with IS 14470: 1997 all applicable tested should be comply. Following Tests at Factory/ Supplier premises are envisaged as below. Complete details of test requirement shall be shared at the time of inspection call. Materials used for structural part of crane should be as per applicable standards and complete testing record should be kept before manufacturing activities. Inspection of testing shall be carried out by a committee from employer.

a) Visual inspection: Visual inspection should include checking for compliance with specifications and/or condition of all vital components such as:

- i. Mechanisms, electrical/hydraulic equipment, safety devices, brakes, controls, and lighting and signalling systems
- ii. Crane metal structures and their connections, ladders, means of access, cabins, platforms
- iii. Hook or other load-handling attachments and their connections
- iv. Ropes and their fastenings
- v. Sheave blocks, their pivots and fastening details and jib linkage elements.

b) Conformity tests: When cranes are tested for conformity to specifications, tests shall be performed according to the crane load characteristics for parameters as applicable as per relevant IS:

- i. Mass of crane (where practical)
- ii. Distance from axis of rotation to the balance edge
- iii. Load lifting height
- iv. Hook approaches
- v. Load lifting speed
- vi. Precision load lowering speed
- vii. Crane travelling speed
- viii. Slewing speed
- ix. Cycle time (where necessary)
- x. Functioning of limiting devices
- xi. Performance of driving medium, for example, motor currents under test load conditions.
- xii. Materials: complete mechanical and chemical test of structural materials as per applicable IS standard for structural grade materials. Standards as mentioned below or equivalent.

-IS 2266 (2002) - Steel wire ropes for general engineering purposes

-IS 807 (2006) - Design, erection and testing (structural portion) of cranes and hoists

-IS 2062:2011, IS 961 for structural steel.

c) Load lifting tests: The following tests shall in general be considered for assessing compliance with IS 14470: 1997

- i) Static Test
- ii) Dynamic Test
- iii) Stability Test

Demonstration at site: A complete tower erection should be showcased at site after supply. Location of tower erection site shall be informed by employer at the time of supply. Erection gang and required manpower shall be arranged by employer. Crane should be demonstrated by supplier at the location for erection of tower.

5. Miscellaneous:

Tools: A complete set of tools required for the maintenance and a set of spare parts for the minimum of 2 years operation after successful commissioning of mobile tower crane should be included. (one set for each crane)

Operating Manual: Complete operating and maintenance manual (Hard copy and soft copy in pen drive disk) in English should be provided with supplied crane.

Training: i. Three days training (batch of 10 person) at factory premises should be provided about functioning of cranes and basic maintenance activities. ii. Three days on-site training on crane operations and troubleshooting of equipment should be provided by qualified OEM authorized personnel. iii. Necessary training from recognized institute for 5 persons should be arranged for getting operator license for supplied crane (if license requirement applicable).

Warranty: Complete Mobile Tower crane setup shall be under warranty for 3 Year from date of successful installation. During warranty period at least one preventive maintenance visit per year shall be provided besides free of cost breakdown repair services, if any. Locations (with in India) for preventive maintenance of supplied crane shall be intimated before service visit.