Specifications for Towers and Civil Works

Scope of work: The scope of works includes supply of Towers and miscellaneous items for the Expansion of GSM Rural B-Mobile project.

1 General

1) This Section covers the technical requirement for towers concerned with the following facilities:
   - Antenna supporting structures and their foundations required

2) Documents and articles necessary for approval by the local approving authorities are as shown in the following table:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Items</th>
<th>Time for Submission</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>List of materials and Machinery-and- tools</td>
<td>Before commencement of the Civil Works.</td>
<td>Three(3)</td>
</tr>
<tr>
<td>B</td>
<td>Test certificates and Reports</td>
<td>Whenever occasion arises</td>
<td>Three (3)</td>
</tr>
<tr>
<td>C</td>
<td>Shop drawings and manufacturer’s drawings</td>
<td>Whenever occasion arises</td>
<td>As specified in this document</td>
</tr>
<tr>
<td>D</td>
<td>Samples and catalogues</td>
<td>Whenever occasion arises</td>
<td>As specified in this document</td>
</tr>
<tr>
<td>E</td>
<td>Any other documents</td>
<td>Whenever demanded by the Employer / Local approving authorities.</td>
<td></td>
</tr>
</tbody>
</table>

The outline of the aforesaid documents and articles are as follows:

a) List of Materials and Machinery-and-tools

Main materials and machinery-and-tools to be used for the execution of the Civil Works shall be listed. The list shall state type and model of the materials and the products, name and address of the manufacturers and conformity of the Standards, and may be classified into two parts: items to be purchased locally and from other countries.

No procurement shall be allowed before approval of the list.

ii) Test Certificates and Reports

Test certificates and reports on the tests carried out at factories, laboratories or at the Sites shall be submitted occasionally. Not only the tests specified in this
specification but also the tests required by the supplier shall be carried out according to the instructions.

iii) Shop Drawings and Manufacturer’s Drawings.

The drawings specified in this Specification shall be submitted according to the Employer’s instructions. The supplier shall submit revised drawings if the Employer so requires. No work shall commence before getting the Employer’s approval to the relevant shop and manufacturer’s drawings.

iv) Samples and Catalogues.

Samples and catalogues shall be specified in this specification.

iv) Any other Documents.

Any other documents specified in this Chapter or the documents directed by the Employer during the progress of the Civil Works shall be submitted.

1.1 Modification of Materials and Methods of Works

Except in cases where the modification of design is required by Employer or the approving authorities, the supplier shall strictly comply with the approved Specifications and Drawings. If the contractor requires modification of designs or alteration of materials and methods of works specified in this document, he shall submit the report stating the reasons for the modifications and the details of such modifications clearly, comprehensively and correctly besides submitting samples of modified materials with relevant specifications from the manufacturers. No modified works shall be carried out before getting the Employer’s consent.

If the bidder feels that the design specified by the employer is inadequate, an alternative design may be proposed at no additional cost to the employer.

2 Design Requirements

The Supplier is required to design the towers of 4 Legged with angular construction for 40M & 30M and 3-legged triangular self supporting tubular tower for the height of 20 meter, 25meter & 30meter considering the following factors:

2.1 General

2.1.1 The supplier shall establish the design conditions of the antenna supporting structures and all the other related facilities to carry out the structural calculations and prepare the drawings and descriptions.

2.1.2 Before commencement of the works specified in section 2.1.1 above, the supplier shall submit the following information for approval by the Employer:

a) The list of standards, which the contractor intends to apply in accordance with this Specification.
b) Grade of steel materials to be used including reinforcing bars and their allowable design stress.

c) Outline of design criteria for structural calculations based on:

   a. Wind load and, if derived from wind tunnel test, method and details of test.
   b. Seismic load where required.
   c. Dead load.
   d. Stress analysis for the telecommunication network facilities, and, if electronic computer is used, explanation on the program to be applied.
   e. Twist, sway and displacement.
   f. Snow load.
   g. Stress analysis for reinforced concrete of the foundation.

d) Allowable bearing strength of soil and, if required, statement of the soil bearings described in this Specification.

e) Typical schematic drawings showing outline of the proposed facilities and structures.

f) Problems on legal conditions of each site relating the design and construction work, including aeronautic laws, if any.

g) Climatic conditions of each site including items relating to wind load, ice coating load and seismic load.

h) Outline of geographical condition of each site

i) Detail time schedule of execution of the design.

j) Other important items to be determined before structural calculation and preparing drawings and specifications.

2.1.3 After completion of preparation of the drawings and descriptions, the following information / details shall be submitted in two (2) copies to the Employer for approval:

   1. Explanation on Design, including:
   2. List of the standards applied.
   3. Special legal conditions of each site relating design of the facilities, if any.
   4. Climatic conditions of each site including items relating to wind load, ice coating load and seismic load.
   5. Details of wind tunnel test if carried out.
   6. Type, size, dimensions weight, quantity and positions of antennas to be mounted on the antenna supporting structure, including future plan.
      i) Structural calculations for the facilities structures, showing:

         ii).Calculation of load, viz. dead load, including ice coating load, wind load and seismic load where required.
iii). Stress analysis and section designs, including:

   a. Line diagram showing each member stress corresponding to various loading conditions.
   b. Tables on load carrying members, listing sizes, lengths, slenderness ratios, allowable stress, actual stress and the sizes and members of bolts at each connection.
   c. Local stress analysis and section design of the structure at the parts on which the antennas and the appurtenances are to be mounted (including adjacent members affected).
   d. Maximum twist, sway and displacement of the main supporting structure in the worst loading condition.

i) Structural calculations for the foundations, including:

   - Load on the foundation by the facilities structure in the various loading conditions.
   - Calculations of stability against uplift, shearing and down-thrust stresses caused by the load.
   - Calculations for the reinforcement.

ii) Drawings, showing:

   Layout of the foundations and facility’s structures station wise, details of the foundations and facility’s structures station wise, and position, dimension and type of the antennas to be mounted on the antenna supporting structure.

2.1.4 Immediately after approval by the Employer, the supplier shall submit three (3) sets of the approved explanation on design, structural calculations, drawings and descriptions.

2.1.5 The approval of the design conditions, calculations, drawings and descriptions shall not relieve the supplier from his responsibility for the accuracy, adequacy and reliability of the facilities to be constructed.

2.1.6 Where necessity of change of the approved design conditions, calculations, drawings and / or description arises, these shall be approved by the Employer.

2.2 Structural Design

2.3 General

a) Unless otherwise specified, the antenna supporting structure shall be self-supporting with self supporting type and the foundation shall be of reinforced concrete.

b) Any stress of component of facilities, of steel, bolt, reinforcing bar and concrete shall not exceed allowable stress of material specified in the Standard.

c) The design for steel structure shall be based on the following concept and assumption incase if the tower structure to be constructed:
a. Steel structure shall be regarded as an elastic body.

b. Steel structure shall be analyzed as a space framework. However, in common trussed structures, the stress may be calculated as a plane, truss of which the members are frame din one plane, substituting the space framework, and furthermore, where the common truss has small inclination, the truss may be calculated on the projection of the truss on the vertical plane. In this case, the following shall be taken into consideration:

   i. Where the inclination of the truss is not uniform, interaction between two inclination
   ii. Other influence caused by construction of the plane trusses as a space framework.

c. Neither the stress caused by dead load including ice coating load, nor the stress resulting from the combined load of dead load and wind load or seismic load shall exceed allowable stress of the materials specified in the Standard.

d) The stress analysis may be carried out by means of electronic computer subject to applying the proven stress analysis program.

e) While designing 3-Legged Self supporting Towers of 20 and 25M a maximum weight for each section member shall not exceed 40Kg/section-leg to ease head load transportation burden to some of difficult sites. While the weight of section member above 25M tower shall not exceed 50kg/section.

2.3.1 Loads on Facility’s Structure

a) Dead Load

Dead load means the dead weight of the antenna supporting structure and all other facility’s structure, all appurtenances and other such items as antennas, which are to be mounted on the main supporting structure.

Where required, dead weight of the ice, which is expected to coat on all members of the antenna supporting structure and all other facility’s structure, the appurtenances, antenna, etc., shall be included in the dead load. At sites over 2,500 meters above sea level, antenna supporting structures, antennas and all other facilities shall be considered for ice coating load.

Unless otherwise specified, radius thickness of the ice coating and density of the ice may be assumed as 10 mm and 0.6 g / cu.cm respectively.

b) Wind Load

a) Full calculation shall be taken in the wind load acting on the antenna supporting structure and all other facilities, the appurtenance and antenna, etc. to be attached
on the main supporting structure. The ice coating, if required, shall be included as a part of the projected area for locations over 2,500 meters above sea level.

b) The combined effects of dead load and wind load shall be taken into calculation in the stress analysis so that the worst stress in all component part can be determined. Where height, direction, size and/or type of the antennas are not specified and they cannot be determined at the stage of structural calculation, these shall be so assumed that they cause the worst effects on the structure when wind load is calculated.

c) Unless otherwise specified, any formulas, coefficients and factors required for calculation of the wind load shall be in accordance with the standard, or the results of tunnel test as an alternative of the Standard.

d) For the purpose of design and calculations, the wind speed shall be taken at 180 Km / hour

c) Seismic load

i) Where required to consider, the combined effect of dead load and seismic load shall be taken into the calculation.

ii) Combined effects of seismic load and wind load may not be taken into the calculation.

iii) The lateral seismic factor may be assumed as \( k = 0.1 \) from the 100 year probability value of 100 gal given in the maximum expected seismicity distribution map of the world published by the Building Research Institute (Ministry of Construction, Japan) or an equally renowned institute, for the calculation.

d) Soil Bearing Capacity

Soil bearing capacity at all the sites is assumed as at least 10 tons / sq.m.

e) Transmission Loss of Telecommunication Network.

Radio transmission loss shall be as follows:-

i) Wind speed 90 km/ h (25m/sec) = Radio transmission loss < 3Db.

ii) Wind speed 150km/h (42m/sec) = Radio transmission loss <20Db.

2.3.2 Twist, Sway and Displacement.

a) Twist means horizontal angular displacement of the main supporting structure at each antenna mounting elevation from no wind load position to worst wind load position.
Sway means vertical angular displacement of the central vertical axis at each antenna mounting elevation from its no wind position to the worst wind load position, divided by each corresponding elevation.

b) Unless otherwise specified, twist, sway and displacement shall not exceed the following values:

a. Twist : 1 deg.
b. Sway : 1 deg.
c. Displacement : 1/100.

2.4 Welding Materials

The electrodes to be used for welding shall be standard products. Appropriate electrodes shall be selected for the type of steel to be welded.

Welding materials other than those stipulated above shall be selected according to the method of welding to be employed.

2.4.1 Bolt Holes.

The diameter of bolt holes shall be larger by 0.5 mm than the diameter of the bolt itself.

Anchor bolts shall be secured by using two (2) nuts.

For bolts, other than those mentioned above, and for those embedded in concrete proper precaution shall be taken to prevent nut loosening by using either double nuts or spring washers or any other acceptable methods.

2.5 Welding.

2.5.1 General

This clause applies to the arc welding of structural steel elements.

a. In-site welding shall be carried out after inspection of the steel fabrication and election.

b. The welding shall be done only by qualified and experienced welders.

2.6 Product Inspection

a) In-shop inspection report of finished products shall be submitted to the Employer for approval.

b) The products shall be inspected by the Employer after the in-shop inspection by the manufacturer.

c) Faulty portions shall be promptly rectified.

3.0 Antenna Support Structure
3.1 General

a) The antenna supporting structure to be constructed shall consist of foundation, main structure, and appurtenances.

b) All steel materials including bolts and nuts shall conform to international standards. All materials of antenna supporting structure including other steel members used in the structure shall be coated by hot-dip galvanizing after all fabrication works has been completed.

c) The antenna supporting structures shall be inspected by the Employer during the construction as well as after the completion of the construction works.

d) A copy of the final drawings and instructions shall be submitted to the Employer promptly after the completion of the antenna supporting structures for the Employer’s record.

3.2 Tower Shape

3.2.1 The towers shall be of triangular shaped lattice self supporting towers, made of tubular members designed to cater total load of maximum 250kg (Max.) which shall consist of 3 nos. GSM antennas and 1 no. microwave/radio antenna etc.

3.2.2 The towers are to be designed for height of 15 meters, 20 meters, 25meters and 30meters for 3-legged self supporting tubular tower.

3.2.3 Each tower shall equipped with a variety of accessories, such as working plate forms (mesh type), antenna mounts, safety devices, ladders, obstruction lights, lightning protection kit etc, which can be installed at any desired height and orientation.

- Antenna Mounting
  
  - Consistent with tower height, towers shall be arranged to support antennas at a number of different levels, 4.0 meters apart, measured vertically.

  This distance may be altered slightly to fit in with the geometry of the tower bracing.

  - Each antenna mounting position shall be capable of being served by an access platform located approximately 1 meter below the centre-line of the antenna position it serves.

  - Mounting platforms shall be provided for all antenna positions, which are to be utilized by the Bidder in meeting the radio system requirements. Mounting platforms are not required for unequipped antenna mounting positions.

  - Antennas shall be mounted on mounting bars to be attached at each mounting level, at set specified vertical distance apart. This
distance shall be specified by the Bidder, but should be typically of the order of 1.5 meters.

Three sectored GSM antennas shall be mounted on bars/pipes of 50mm-100mm in diameter and 3000mm in length. In addition, two similar bars/pipes shall be provided below the GSM antenna for mounting the radio antenna.

- Appropriately sized holes shall be provided in the tower legs at each mounting level for mounting bars to be added as required for future radio systems.
- Bidders shall allow for 2 pairs of holes per leg on each face at each mounting level.

- **Antenna Feeder Runway**
  - Each tower shall be equipped with a straight, vertical antenna feeder runway extending from the ground to the top of each tower for the provision of coaxial cable and wave guide feeders as necessary. This runway shall have provision for future radio system expansion of:
    - 10 cables -16mm Dia.
    - 10 cables/waveguides -28mm Dia.

    - For towers with a central runway, the lower end of the runway shall be set in a concrete foundation laid on a solid base. Typically this would consist of a concrete foundation block approximately 1.0m x 0.4m deep.

    - The Bidder shall include design details for a suitable sized antenna feeder gantry extending from the tower structure to the equipment building. This gantry shall be of sturdy construction utilizing galvanized steel members and offer some protection to the feeder cables in the event of flying debris in high winds. Feeder cables should preferably be laid on the underside of the gantry.

- **Platforms**
  - Working platforms shall be provided to allow access to each antenna equipped for the initial installation specified in these bidding documents.

  - In addition rest platforms shall be provided on all towers where the vertical spacing between working platforms, or the lowest working platform and ground level, exceeds 15 meters. Rest platforms, where practicable, shall be provided at levels, which coincide with the levels of the working platform for antenna mounting positions.
- Platform decking shall be of expanded metal mesh, or similar construction, and shall be adequately supported on steel members of appropriate size.

- **Guard Rails**
  - Platforms shall be provided with handrails at a height of approximately 1 meter above the decking, intermediate rails at approximately 0.5 meter above the decking and kick rails at the decking level.
  - All rails shall consist of suitably sized rolled steel angle section.
  - Guardrails shall be provided on all platforms and shall be continuous around the outside perimeter and the runway opening of each platform and shall encompass the ladder and ladder guard so that free access to the ladder may be gained from the platforms.
  - Handrails on platforms shall not be structural members and shall be removable to facilitate the mounting of antennas.

- **Ladders**
  - Steel ladders with ladder guards shall be provided from ground level to the highest working platform on each tower.
  - The ladder guard shall be so arranged that at each antenna mounting level, a section may be removed to provide access to the further platform without having cut to the vertical strips.
  - Ladder shall, where practicable, continue for a distance of at least one meter above the upper surface of the platform that is served. The stainless shall not, however, project above the top of a tower.
  - Ladders, ladders guards and ladders support shall not infringe on the space reserved for antenna feeders.
  - Ladders shall be adequately supported to resist lateral movement.

- **Lightning Protection**
  - Two lightning discharge rods of height approximately 2.4 meters shall be securely fixed to the top of each tower on diagonally opposite corners.
  - Each rod shall consist of a steel tube with four 13mm diameter rods of length 0.5 meter (approximately) welded to the top of the tube, disposed equally around the tube and splayed upwards at 45 degrees.
  - No separate earth conductor need be provided from the discharge rods to ground and it is necessary, therefore, that all bolted connections in the tower should be free from paint and
reasonably clean at the time of assembly. This applies particularly to the point of attachment of the discharge rods to the top of the tower.

- **Earthing**

  - An earthing system, generally to the provisions of internationally accepted standard shall be provided at each tower. This shall consist of at least one radial earth strap extending from each tower leg, one loop encircling the tower and a separate loop encircling the equipment building.

  - Particular attention shall be paid to the bonding of earthing straps to tower, runway, gantry and building steelwork.

  - Earthing strap shall consist of pure copper of nominal dimensions 3cm x 2.5 cm.

  - The completed earth system shall have a resistance of less than 2 ohms, when measured with a specific earth resistance-measuring instrument.

### 3.3.0 Trial Erection

Where deemed necessary by the Contractor or indicated by the Employer, the members fabricated shall be erected on trial basis in the factory at the contractor’s cost before transportation in order to confirm accuracy and other requirements of the fabrication.

### 3.4.0 Complete Tower

3.4.1 Each erected tower, under conditions of negligible wind, shall not deviate from the vertical position by more than one-eighth of one percent of its height.

3.4.2 Each erected tower, under conditions of negligible wind, shall be straight within 25mm of the nominal geometric position.

3.4.3 Each erected tower shall be free of inherent twist.

3.4.4 Where bolts are placed in a generally vertical position, the bolt heads shall be uppermost.

### 3.5.0 Lighting

3.5.1 Where tower lighting is required the tower shall be equipped with suitable air navigation warning lighting.

3.5.2 Two 100 watt weather-proof incandescent globes shall be installed at the tower top.
3.5.3 Operation shall be from 220 volt AC supply and all power conduits shall be of galvanized iron construction. PVC or other plastic conduit is not acceptable.

**Additional Information:** The weight and base details shall be as under:

<table>
<thead>
<tr>
<th>Tower Ht.</th>
<th>Base Size (Approx) for 4-legged angular tower</th>
<th>Weight for 4-legged tower</th>
<th>Base size for 3-legged tubular tower</th>
<th>Weight for 3-legged tubular tower</th>
</tr>
</thead>
<tbody>
<tr>
<td>40M</td>
<td>4500mm</td>
<td>9800KG</td>
<td>4862mm</td>
<td>6600KG</td>
</tr>
<tr>
<td>30M</td>
<td>3500mm</td>
<td>7200KG</td>
<td>3874mm</td>
<td>4600KG</td>
</tr>
<tr>
<td>25M</td>
<td>3000mm</td>
<td>6000 KG</td>
<td>3500mm</td>
<td>4200KG</td>
</tr>
<tr>
<td>20M</td>
<td>2550 mm</td>
<td>4300KG</td>
<td>2800mm</td>
<td>3900KG</td>
</tr>
</tbody>
</table>

Superstructure: Tower has a tapering structure except for the top 7.5m.

*Note: Weight of tower is inclusive of all parts of Superstructure (including the weight of MW/GSM antennas mounting arrangement i.e. antenna fixtures, Horizontal cable Tray (6 m) along with foundation Bolts &Templates) and must not be less than the weights mentioned above.

The bidder must adhere to following Specification in order to qualify for the supply of Tower:

**Material specification:** MS angles of grade ‘A’ as Per IS: 2062 (1999) with latest amendment and IS: 808(1989) shall he used. All MS angles are to be hot dip galvanized as per IS: 4759(1996), Standard zinc for galvanizing should conform to IS: 13229 (1991) or IS:209(1992).


**Nuts, Bolts & Washers:** Nuts & Bolts of grade 5.6 as per IS 6639(1972)/ IS 1364, IS: 1367 part8 (1992), and Plain washers as per IS 6610 (1972) & spring washers Type B as per IS 3063:1994 shall be used.

**ELIGIBILITY CRITERIA FOR TOWER TENDER**

1. Bidder should be registered manufacturer of Telecom Towers or authorized agent of OEM. In addition to this Bidder must have Supplied towers to at least two countries besides the country of origin.

2. OEM can submit one bid only, either directly or through any authorized supplier. Manufacturer authorization certificate to be enclosed with the bid in case of authorized agent is submitting the bid.

3. Infrastructure approval from any PSU/Govt undertaking. Certificate to be enclosed at the time of Bidding.

4. The Manufacturer should have its own Galvanizing plant of size sufficient to galvanize in house, all tower members.

6. Average Annual Financial Turnover of the bidder during the last 3 years, ending March 2011 should be at least Rs.5 Crores.

7. Experience of successfully executing 5 orders of similar work for Govt/PSU of valuing not less than Rs 60 Lakh each during the last 4 years ending Dec 2011. Similar work includes supply, execution, Testing and Commissioning of Telecom Towers. Completion Certificate from Govt/PSU to be enclosed with the Bid.

8. The bidder must have the experience of execution of at least 3 orders for SITC of towers in hilly terrain.