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Functional Specification

Steel Masts & Girders

Revision	Date	Description	Originator	Reviewer	Checker	Approver
R0	20/04/2022	First Issue	Vitali Garon	Daniele Giustini	Leon Notkevich, Neil Cowap	Aidan Corcoran, Richard Blanchfield
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1 SCOPE

This functional specification defines requirements for the design & testing of steel masts, girders including lightning masts for use in Onshore Compensation Compounds (OCC) that will be owned and operated by EirGrid as part of Offshore Wind Power developments.

2 WORKS FOR OCC MASTS AND GIRDERS

The design and fabrication of steel work for masts and girders for the OCC civil, building and associated structure works shall be undertaken by the Customer and shall include but is not limited to:-

1. Design, Drawings and structural calculations
2. Fabrication (temporary and permanent steelwork)
3. Protection
4. Delivery
5. Erection (temporary and permanent works)
6. Certification and testing of all materials, steel members, welds, components and mechanical fixings.

3 LEGISLATION CODES AND STANDARDS

3.1 LEGISLATION

To prove compliance, the steel masts and associated equipment shall carry the CE Mark in accordance with Direction 768/2008/EC and the EU Construction Products Regulation (No. 305/2011 – CPR) where required.

In addition, there shall be compliance with the provisions of all current relevant Directives of the European Communities and the Republic of Ireland relating to design, workmanship, materials and equipment. It is the responsibility of the Customer to oversee compliance with current Codes and Standards (Refer to) .

3.2 NATIONAL INTERNATIONAL AND OTHER APPLICABLE STANDARDS

Except where otherwise stated in the functional specification, materials shall be designed, manufactured, tested and installed according to relevant IEC and/or EN standards.

Where available, the Irish adaptation of European standards (IS EN version), including any national normative aspects shall be applied.

Where no IEC standard or EN standard has been issued to cover a particular subject then an international or British Standard shall be applied. The latest edition and amendments shall apply in all cases.

The equipment shall comply with the latest editions of the international standards, codes and normative references indicated below, and the latest editions of the standards that they reference.

3.3 HEALTH AND SAFETY

The Customer is considered to undertake the role of “Client” under the Safety, Health and Welfare at Work (Construction) Regulations 2013 (referred to as the “Regulations” in this document) and responsible for the design. The Customer shall take due account of EirGrid’s Safe by Design Methodology XDS-SDM-00-001-R0.

The Customer is solely responsible for Safety on Site. The project shall be managed in accordance with the Safety Health & Welfare at Work Act 2005 as amended and in compliance with the Safety Health and Welfare at Work (Construction) Regulations 2013.

The Customer and their appointed PSDP and PSCS shall be responsible for compliance, preparation of and liaison with relevant bodies in respect of all documentation associated with the above regulations including but not limited to: -

- Design Risk Assessments,
- Temporary and Permanent Works Certificates,
- Notifications to the HSA (AF1 & AF2),
- Preliminary and Construction Stage Safety & Health Plans,
- Risk Assessments and Method Statements (RAMS), and
- Safety File and as built steel fabrication drawings.

3.4 SUSTAINABILITY

The Customer shall ensure that the principles of sustainability are employed in the design and build process by providing steelwork structures that fulfils its intended function and sustain the specified loads for its intended life, with due regard to sustainability, robustness, economy, and health and safety.

The Steelwork girders and masts processes shall provide methods that are sustainable and safer through the design and construction phases including .-

- fabrication,
- transportation,
- handling,
- erection,
- temporary and permanent stability of the girders and steel masts.
- operations and maintenance.

The Customer shall demonstrate through their Environmental Management Systems that all parties in their supply chain have taken practical steps to reduce the greenhouse gas emissions of the processes over which they have control.

The Customer should design, procure, detail and fabricate structural steelwork to minimise materials used and reduce waste. The design and detailing of structural steelwork should facilitate its recovery for reuse at its end-of-life stage as part of the circular economy and that all Steel making processes makes full use of available scrap material.

3.5 Quality Control and Assurance for Steel Fabrication

During the OCC design and build processes , the Customer in a timely manner shall make available in the factory, and/or at site works locations in advance of any works as applicable , for each of the areas as requested for review/ inspection by EirGrid.

This will cover but not limited to the following areas and associated activities:-

1. Witnessing by EirGrid of the full assembly and adjustment process to evaluate the level of skill and experience required to complete each key works activity successfully.
2. Access to QC/QA documents including Risk Assessments and Method Statements (RAMS), work procedures, drawings. checklists, samples , Inspection schedules & test plan, Project Quality Control plan, certifications, audits and other documents for materials used for masts and girders including the steel superstructures, concrete , steel reinforcement and piling systems undertaken for the civil, structural and building processes required for the delivery of the OCC.
3. EirGrid will also review the fabrication and on-site erection of the steel masts/ girders and the overall clarity of the Customers steelwork installation manual for each girder and mast.
4. A detailed inspection of the steel fabrication by EirGrid to evaluate the Customers quality of the design and manufacture in relation to finishes, structural integrity and corrosion resistance, elimination or control of possible failure mechanisms and ease of operation and maintenance

3.6 Weather and Climate services conditions

The OCC and associated buildings, plant and equipment will be located in exposed locations, likely to be less than 1,000 metres above sea-level. The Customer's design for the OCC Steel masts and girders shall consider the structural and environmental impact on ferrous metals based on temperatures, humidity and wind speeds bespoke to the project's location.

As a guide the following climate and weather conditions may apply: -

Table 1 Service Conditions

Item	Value
Maximum ambient temperature	40°C
Maximum daily average ambient temperature	20°C
Annual average ambient temperature	30°C
The maximum wind (gust) velocity	50 m/s

The relevant Eurocode design standard, IS EN 1991-1-4, is normally used to assess the dynamic effects of wind loading on wind-sensitive structures.

Weather and temperature for project locations may be obtained from the Met Eireann, Ireland's National Meteorological Service, (Department of Housing, Local Government and Heritage).

3.7 GENERAL REQUIREMENTS

The Customer shall prepare and submit complete detailed working drawings for masts and girders to EirGrid in a timely manner for review.

These drawings shall indicate :-

1. Detailed calculations of the load, actual stress and permissible stress in each member and the actual and permissible load in each joint.
2. Details of all joints.
3. Outline dimensions and thickness of all structural members, gusset plates and other parts.
4. Details of mechanical fasteners including:-
5. Diameters and lengths of all bolts.
6. The identification number of each part or member.
7. Centre to centre distances of all bolt holes.
8. Size and thickness of all washers
9. Steel fire and corrosion protection
10. Detail steel connections at foundations including depth of sockets or base and anchor plates, holding down bolts and grouting.
11. Details reinforced or mass concrete foundations
12. Details of Earthing

4 BASIS OF DESIGN FOR MASTS AND GIRDERS

The design of steel masts including guyed masts and girders shall be in accordance with the general rules given in EN 1990. The provisions for steel structures given in EN 1993-1-1 should also be applied.

In addition, guyed masts shall be designed to withstand the rupture of one guy without collapsing. Principles of limit state design shall conform to EN 1993-1-1.

The design wind actions should be taken from EN 1991-1-4 . Thermal actions should be determined from EN 1991-1-5 for environmental temperatures. Self-weight should be in accordance with EN 1991-1-1 and for self-weight and tensioning of guys they shall be determined in accordance with EN 1993-1-11.

Members that are within [30°] to the horizontal should be designed to carry the weight of a workman which may be taken as a concentrated vertical load of 1kN. Imposed loads on platforms and railing should be considered. The following characteristic loads are recommended:-

1. Imposed loads on platforms: 2.0 kN/m2
2. Horizontal loads on railings: 0.5 kN/m

4.1 SAFETY ERECTION

Actions for accidents and collisions shall comply with EN 1991-1-7. Actions during erection of masts should consider the construction scheme. The appropriate load combinations and reduction factors may be obtained from EN 1991-1-6. Ice loading shall comply with the design parameters stated in ISO 12494.

Actions arising from the fitting and anchoring of safety access equipment may be determined with reference to EN 795. Where the proposed safe method of working requires the use of Work Positioning Systems or mobile fall arrest systems points of attachment should be adequate (refer to EN 365).

Any ultimate limit verifications and testing by design integrated into the Customers Design and shall comply with EN 1990.

Tolerances for maximum displacement of lattice masts (towers) top shall be not more than 1/500 of the height of the mast. Guyed masts final plumbing and tensioning parameters are stated within Annex F of I.S. EN 1993-3-1:2006.

4.2 STRUCTURAL ANALYSIS

The internal forces and moments should be determined using elastic global analysis(see EN 1993-1-1). Gross cross-sectional properties may be used in the analysis. Account should be taken of the deformation characteristics of the foundations in the design of the structure (see EN 1993-1-1). Lattice masts and guys should be analysed considering the effect of deformations on the equilibrium conditions refer to I.S. EN 1993-1-1. The global analysis of a mast or guys should consider the non-linear behaviour of the guys, see EN 1993-1-11.

The procedure for the analysis of Modelling for Connections procedures for fully and non-triangulated structures are referred to EN 1993-1-8.

Ultimate limit states are defined in Section 6 of I.S. EN 1993-3 with resistance of guys and their terminations defined in EN 1993-1-11.

Resistance of cross sections for masts and towers, classification of cross-sections is given in EN 1993-1-1. Strength for guy and fittings refer to EN 1993-1-11.

Mechanical fasteners and welded connections including tension in bolts, anchor plates and in end plates are to comply with EN 1993-1-8. Minimum bolt diameter to be 12mm.

Special connections for masts for spherical pinned connections should be based on the design rules for rocker bearings, see EN 1337-6.

Serviceability limit site may be applicable and should comply with EN 1993-1-1 in relation to deflection and rotations. Vibrations should be examined for dynamic effects in accordance with EN 1991-1-4 and Annex B and Annex B of EN 1993-3-2.

Fatigue verifications and safety assessment for fatigue should be applied in accordance with EN 1993-1-9 and as defined in I.S. EN 1993-3-1.

5 Fabrication of Masts and Girders

5.1 Drawings for Masts and Girders

Fabrication steelwork, masts and erection drawings shall be produced in accordance with BS EN ISO 4157 and I.S. EN ISO 129.

2D drawings to be in AutoCAD with pdf copies (in duplicate) and include for 3D Modelling to produce Fabrication Drawings.

The Customer design shall provide drawings using a 3D Modelling Software (StruCAD/Telka Structures or equivalent). The model shall be issued in a format suitable for the 3D Modelling Viewer and a format suitable for import to Autodesk REVIT.

5.2 Execution

Masts should be fabricated and erected temporarily or otherwise, shall comply with IS EN 1090-2 and bear a CE mark. Bolted connections should be fitted with suitable measures to avoid any loosening of nuts in service. Fitted or friction grip bolts, or closer tolerances on bolt holes than those given in EN 1993-1-1 may be used. The following documents shall be obtained by the Customer in advance of any fabrication of masts and girders and be included as part of their Quality systems. :-

- Factory Production Control (FPC) Certificate, appropriate for the Works, originating from a Notified Body
- Welding Certificates, appropriate for the Works, originating from a Notified Body
- Declaration of Performance (DOP) Certificate as required by the European Construction Products Regulations 305/2011 (ECPR) . A performance shall be declared to meet all the requirements of this Specification and as set out in IS EN 1090 as a minimum

5.3 Steel Materials

The Customer design for structural steel for masts and girders shall meet the requirements and properties for structural steel as defined in EN 1993-1-1 and EN 1993-1-3. For toughness requirements refer to EN 1993-1-10. Connections shall meet the requirements and properties for bolts and welding consumables as defined in EN 1993-1-8. Guys and fittings requirements and properties of ropes, strands, wires and fittings shall comply to EN 1993-1-11.

All steel in plate, section and bar forms shall comply with IS EN 10025 or similar approved standard. Structural hollow sections shall be hot rolled in Grade S355JOH to IS EN 10210.

Welded cold formed structural hollow sections shall not be substituted for hot rolled sections.

Identifying marks for the different grades of steel shall be provided in accordance with IS EN 10025.

Except in the case of special plate with through thickness properties guaranteed by the manufacturer, all plates and sections 40 mm or over in thickness shall be ultrasonically tested for laminations and shall meet the requirements of Class S1 of IS EN 10160.

The Customer's Design may specify that other plates be ultrasonically tested and, unless otherwise specified, they shall meet the requirements of Class S1 of IS EN 10160.

6 MECHANICAL FASTENERS(BOLTS, NUTS AND WASHERS)

All structural grading for Bolts used in the fabrication, temporary and permanent stability of the girders and masts including cast- in foundation bolts to be as per Customers Design.

Supply and verification of mechanical fasteners will be from an organisation with a current quality management system complying with EN ISO 9001. Conformity assessment and application of structural mechanical fasteners shall be undertaken in accordance with IS EN 1090-1/2. A declaration of performance under a CE mark in accordance with the Construction Products Regulations shall be provided for all structural steel components. All mechanical fasteners to conform to Customers specification and relevant design details.

The use of bolts, including permissible stresses, size and pitch of bolts shall comply with the requirements of IS EN 1993, IS EN 14399 Series and IS EN 1090 . The combination of bolts and nuts (and washer if used) which may be used shall be to the requirements of IS EN 15048.

Fasteners shall have CE marking for load ability as specified in IS EN 15048-2.

Unless otherwise agreed, bolts shall be provided with a washer under the nut. A suitable plate or heavy-duty washer shall be used under the head and/or nut where there are oversized or slotted holes. Plate washers shall not be thinner than 4 mm.

If the bolt head or nut is in contact with a surface which is inclined at more than 2 degrees from a plane at right angles to the bolt axis a taper washer shall be placed to achieve satisfactory bearing.

Nut blanks shall be tapped after being galvanised. Galvanising and re-tapping of nuts is not permitted.

Bolts may be assembled using power tools or shall be fully tightened by hand using appropriate spanners in accordance with BS 2583. Counter nuts or spring washers to be used on connections subjected to a dynamic or quasi-dynamic loading.

Fabricated process shall ensure that bolt threads after galvanising the nut can be easily screwed over the whole threaded length without excessive play. The threaded length shall be such that the nut can be fully tightened up, but also that the minimum practical amount of thread lies between the sections being jointed and that at least two and at most four threads of the bolt shall project through the nut when fully tightened.

Washers to suit nuts and flanges shall be used under all nuts and provided where

necessary on tapered flanges. Where nuts and bolts for assembly on site are supplied with any structure, an additional contingency of 5% of the total number of all nuts, bolts, washers and pack washers shall be provided.

6.1 TOLERANCES

Dimensional tolerances of steelwork for :

I. Hot rolled sections shall comply with IS EN 10365, IS EN 10210-2, IS EN 10056-1 and IS EN 10034
II. Cold formed section shall comply with IS EN 10162
III. Plates and flats shall comply with IS EN 10029 / IS EN 10051

Unless otherwise agreed, ordinary bolts and nuts shall generally be Grade 8.8. Pre-loaded bolts, nuts and washers shall comply with IS EN 14399. Design and associated detailing for fatigue shall be in accordance with IS EN 1993-1-9.

Further reference to concrete and steelwork to be used in the OCC may be found in EirGrid functional specification OFS-SSS-417 and OFS-SSS-419. Specification for Corrosion protection using hot dip galvanising may be found with OFS-SSS-420.

6.2 WELDING

Welding shall be a metal arc process in accordance with IS EN 1011-1, and comply with IS EN 1011-2. The Customer's QC/QA system for the management of welding shall meet the standard quality requirements described in IS EN ISO 3834-3. Electrodes for metal arc welding shall comply with the requirements of IS EN ISO 2560. Ordinary bolts and nuts shall comply with BS 3692 and BS 4190.

Weld Procedure Specification (WPS) and Qualification Records (WPQR) shall comply with EXC 2 in IS EN 1090-2. Welder procedure qualification (WPQ) acceptance levels shall comply with IS EN ISO 15614 and to EXC 2 . The IS EN ISO 3834 quality process for welding shall conform to the requirements for EXC 2.

All welding as part of the Quality documentation (welder qualifications, welding procedure qualification records, welding procedure qualifications and associated work instructions) shall be audited and reviewed by the Customer's person responsible for welding coordination.

The Customer's shall ensure that constituent product materials to be welded are compatible with the welding procedure approved. Joints shall be prepared in accordance with IS EN ISO 9692-1 and -2. Precautions shall be taken to ensure cleanliness of the connection prior to welding.

Customer shall ensure that welding operators are tested to meet the requirements of IS EN ISO 9606-1 and IS EN ISO 14732, as appropriate.

The Customer as part of their Quality systems shall produce and carry out welding procedures that comply with IS EN ISO 15609-1.

At joints in all steelwork, surfaces to be welded shall be restored to Sa2½ 'IS EN ISO

8501-1 quality or to bright steel taken back min 75mm and shall be free of any protective or other coating immediately prior to welding(refer to Section 6).

The use of shims shall be avoided where possible by suitable controls on preparation, assembly and weld distortion and, if necessary, by machining.

Welding including shims if required shall be carried out in accordance with IS EN 1090-2.

If the temporary tack weld is to be removed prior to welding of the joint, the minimum permitted size of tack weld shall be subject to a welding procedure test in accordance with IS EN ISO 15614-1. If the tack weld is to be left in the joint, then the full length of the tack weld location shall be subjected to a welding procedure test in accordance with IS EN ISO 15614-1.

The Customer shall ensure that all welding is carried out under the supervision of a competent and experienced welding supervisor. The Customer as part of the Quality procedures shall keep all records at main welds and the welders identification, in particular at butt welds.

6.2.1 TESTING OF WELDS

Routine testing includes 100% visual inspection and a supplementary programme of non-destructive testing (NDT) which shall be undertaken by the Customer in accordance with their Quality procedures to ensure that the welding processes and welding operators are producing work of a quality that is consistent with Execution Class 2. The benchmark for the quality of work required for Execution Class 2 is generally quality level C to IS EN ISO 5817. The supplementary programme of NDT shall be in accordance with IS EN ISO 17635.

All welds are to be visually inspected by the Customers competent person and in accordance with IS EN ISO 17637 over the full length of the weld and before NDT inspection is performed.

Non-Destructive Testing [NDT] shall be carried out in accordance with the guidelines in IS EN ISO 17635. Customer shall carry out NDT with their competent person who shall be certified by an authorised qualifying body in accordance with IS EN ISO 9712.

If examination of a weld surface is required, magnetic particle testing shall be used in accordance with the recommendations given in IS EN ISO 17638 and this shall be preceded by visual inspection undertaken by the Customers NDT competent person . If magnetic particle testing is impractical, penetrant testing may be used in accordance with the recommendations given in IS EN ISO 3452-1.

Operators carrying out final surface flaw detection of the weld shall hold a current certificate of competence to Level 2 according to IS EN ISO 9712 in surface flaw detection of the relevant types of work, from a recognised authority.

If ultrasonic testing is required, it shall be carried out in accordance with IS EN ISO 17640, IS EN ISO 11666 using reference level to technique 1, evaluation reference level -14dB and testing level B unless determined otherwise by the Customer’s Design.

6.2.2 CERTIFICATION

Two copies of the manufacturer's test certificate and mill certification verifying that the materials comply with the relevant European Standards or approved equivalent standards.

These shall form part of the Customers Quality documentation that will form part of the handover documents that shall be submitted to EirGrid in relation to all structural steel, bolting materials and welding consumables.

6.2.3 MARKING AND PACKING

Fabricated Steel structures shall be marked as shown on the Customers drawings or on associated steelwork and fabrication documentation.

For lattice steel structures which are to be bolted together on site, each member shall be quality approved and stamped before galvanising as applicable and positioned close to one end with the identification number shown on the reviewed drawing. Such identification numbers shall be at least 12mm high and deep enough to be clearly legible after galvanising

7 TESTING ON MASTS AND GIRDERS

The Customer shall submit the following:

- Full details of the testing facility
- Details of type tests that were carried out on similar structures.

Test procedure shall be in accordance with IEC 60652 but the specified loads in each test shall be sustained for 5 minutes.

All steel used in the fabrication process for masts and girders shall be tested in accordance with the Customers quality procedures and compliant with IS EN 1090-2 and standards / codes listed in this specification.

Copies of testing , sampling, materials , records signed certificates shall be supplied as part of the Customers quality plan and issued to EirGrid in a timely manner for review.

Inspection and sample testing of the mechanical fasteners to be used in the OCC shall be in accordance with IS EN ISO 3269:2001, to confirm that the dimensional and mechanical properties comply with the product standard to which the mechanical fasteners have been mechanically manufactured

Sampling and testing for any of the steel fabrication and associated component for the works that results in non-compliance with the specification or relevant codes and standards may result in the intensification of testing and whole consignments being rejected.

All components for the exposed masts and/or girders shall be galvanised and tested to comply with, EN ISO 1461 and reference to EirGrid Specification, OFS-SSS-420.

Testing requirements for Protection against falls from a height and Anchor devices shall conform to EN 795. Further tests which may be necessary if a failure occurs below the specified loads as deemed necessary by the Customer.

7.1 INSPECTION

The Customer shall inspect the steel fabrication masts and girders to ensure specified standards and designs are being met. As part of the Customers Quality documentation their detailed records of such inspections shall be recorded and shall be made available to EirGrid as part of the handover documentation.

EirGrid also reserves the right to inspect the steelwork before and/or during fabrication and should be given every co-operation during these visits.

8 PROTECTION OF STEELWORK FINISH

8.1 PREPARATION OF STEELWORK

Steelwork shall be blast cleaned to remove all mill scale and other contamination to IS EN ISO 8501-3 and BS 7079. The surface finish shall be to standard preparation grade Sa 2½ in accordance with IS EN ISO 8501-1 and IS EN ISO 12944-4. Abrasive used during blast cleaning shall be selected in accordance with IS EN ISO 11124 and IS EN ISO 8501-3 and BS 7079. Sand blasting shall not be used.

Any contamination of the treated steelwork surface shall be removed, using an approved solvent solution, before further protective coatings are applied. The finishing coats to all structural steel shall be a colour as specified by the Customer's Design, in accordance with BS 381C and BS 4800.

8.2 CORROSION PROTECTION AND HOT DIP GALVANISING OF STEELWORK

All external steelwork unless otherwise specified by the Customers Design , including exposed holding down bolts and internal steelwork below ground floor level shall be hot dipped galvanised. The requirements for the corrosion protection for steelwork shall comply with IS EN 1090-2.

The steelwork and components including nuts (excluding treads), bolts and washers, that are to be hot dip galvanised shall comply with IS EN ISO 1461. Further reference for the required Hot Dip Galvanising process of steelwork refer to EirGrid Specification OFS-SSS-420.

8.3 REPAIRS TO STEEL PROTECTION SYSTEMS AT WELDS

All welds shall be apply corrosive protection in accordance with IS EN 1090-2 and treated and protected with hot dip galvanised in accordance with EN ISO 1461. On site, surfaces of hot dip galvanized components which the Customer has deemed to have minor damage this shall be prepared by : -.

Clean bare steel or steel-zinc alloy using needle gun and/or rotary wire brush. Clean, degrease, wash down and dry, thinned and adjacent sound galvanised surfaces.

Immediately apply zinc-rich paint to bared steel or steel-zinc alloy and thinned galvanising, overlapping sound galvanised surfaces by minimum 20 mm, to give protection equal to

that on undamaged surfaces with two coats of Zinc Rich Epoxy Blast Primer, minimum dry film thickness of 50 microns each.
Alternatively, the Customer shall ensure the steelwork and components are re-galvanized.

8.3.1 INSPECTION

Inspections to measure zinc thickness shall be with magnetic or the single value from a gravimetric test and must be re-galvanised if thickness is deficient. All galvanized components shall be subjected to 100% post-galvanizing inspection in accordance with procedure PGI-1 in Table 10.1 of NSSSBC (National Structural Steelwork Specification for Building Construction) unless otherwise specified by the Customer.

The drawings shall identify: -
Any components for which post-galvanizing inspection is not required (PGI-0).
Any components that shall be subjected to procedure PGI-2A.
Any specific locations that shall be subjected to procedure PGI-2B

8.4 FIRE PROTECTION

Fire protection for fabricated steelwork and girders to buildings within the OCC shall be treated with intumescent paint coating to provide a 60 minute fire resistance (or higher if required by the Fire Safety Certificate) and shall comply with TGD B -Fire Safety of the Building Regulations as Amended, BS 476-21:1987 and BS EN 1993-1-2:2005. Third party certification installers of fire protection systems, materials, products or structures for all paint protection systems shall form part of the Customers Quality Control documentation.

8.5 FIRE PROTECTION - REPAIR OF DAMAGED COATINGS

Before carrying out on-site remedial works a written Method Statement for repair procedures shall be prepared by the Customer and submitted to EirGrid for review.

The Customer is responsible for identifying all areas requiring remedial works and rectification in accordance with the coating manufacturer's recommendations.

Where the dry film thickness(dft) of the intumescent coating does not comply with the nominal DFT with that required to provide the specified fire resistance then remedial works will be needed to bring the affected area(s) up to the required thicknesses.The areas must be locally abraded with any damage removed. Re-apply primer, intumescent coat and top sealer coat to original specification. Do not overlap existing intumescent with new primer, or existing top sealer with new intumescent.

Where unscheduled additional connections are to be made to the erected steelwork the intumescent coating is to be removed locally and reinstated.

9 LIGHTNING MAST RODS AND EARTHING

9.1 LIGHTNING MAST RODS

Lightning rods shall be fitted to all Masts. The lightning protections shall sufficiently cover the entire station equipment as per the requirements of DIN VDE 0101.

9.2 EARTHING SYSTEM

Customer design to supply and fix comprehensive lightning protection shall refer to EirGrid Earthing and Lightning specification OFS-SSS-407. The design for protection against lighning including conductive strapping and requisite earth connection points shall be in accordance with IS EN: 62305. The design for lightning protection system and components shall further comply with IS EN 62561.

The earthing design to the OCC masts , building, structures and associated civil works shall be submitted to EirGrid for review prior to construction commencement.

OFS-SSD-513 General Arrangement - Earthing practice indicates standard arrangements for integration of internal OCC plant, equipment and building elements with the external buried station earthing system including the following drawings :

- Earthing Practice Installation Details
- Control Building Earthing (AIS Substation).
- GIS Room Earthing.
- GIS High Frequency Mesh/ Rebar.
- GIS Floor Rebar Earthing Detail.
- Earth Tail entering raised floor
- Earth Tail entering cable pit.
- Earth Tail entering ground floor level.
- Structural Steel Earthing.

This section represents a basis for the functional earthing requirements and should be verified for suitability by the Customers Design on a case by case basis for all masts. Other References to earthing systems refer to Drawing ‘OFS-SSD-513 General Arrangement - Earthing practice’.

9.3 EARTHING TAILS CONNECTION TO STEELWORK AND REINFORCEMENT

Two 13.5 mm dia. holes for an earthising connector shall be provided on every mast leg. This hole shall be located about 300 mm above base. Its precise position shall be agreed with the mast fabricator. Should cleats be used to facilitate earth connection of the masts steelwork to the earth grid they are to be protected from painting during the fabrication process.

Earth tails shall be protected and placed into concrete works and passed under shutters before connecting to the earth grid. Disks shall be placed on the soffits of foundation slabs to tie the earthing into the mast .

If required to provide a continuous steel conductive path in the foundation slabs, the reinforcement bars are to be welded at crossover points at designed intervals prior to pouring concrete. Bolting, saddles and clamping of copper conductor to reinforcement at

intervals shall be with galvanised steel 'U' bolt and saddles to IS EN 13411-5. Protection Code of practice for protective earthing of electrical installation shall comply with BS 7430:2011+A1:2015.

10 FOUNDATIONS

The design for mass or reinforced concrete foundations shall be primarily based on;-

- Eurocode 1: Actions on structures
- Eurocode 2: Design of concrete structures
- Eurocode 3: Design of steel structures
- Eurocode 4: Design of composite steel and concrete structures
- Eurocode 7: Geotechnical design

The design for all foundations shall be based on the Geotechnical Site investigation Report. The Customer shall provide information to justify the adequacy of their proposals, if so requested by EirGrid. Any excavations for underpinning or any excavations adjacent to existing or proposed foundations shall be carried out and supported in such a manner as to prevent damage to adjacent structures or buildings and avoid adversely affecting the ground upon which it is intended to build. The Customer shall comply with all the requirements of the Local Authority regarding the notification, inspection and approval of all excavations and formation levels.

Masts that are to be fixed to concrete foundations including for for all mechanical fixings, holding down bolts, templates and plates shall be to the Customers Design.

To facilitate the installation of foundations on site in advance of the delivery of the masts the holding down plates and anchor bolts based on the approved template shall be programmed and provided to ensure the compatibility with the masts and allow for the casting and placing of the anchor bolts in advance of erection of the masts.

10.1 DESIGN FOUNDATION WORKS FOR OCC MASTS STRUCTURES

The design of the foundations shall take account of the ground conditions and the forces exerted by the mast structures in order to assess the mass concrete or reinforced concrete provided where necessary.

Limit State method of design and/or crack checks shall be used to calculate the reinforcement. A suitable bolting arrangement shall be provided to connect the equipment supporting structures to the foundation. Foundation tolerance shall be such that water does not collect on foundations. Shimmering and grouting should be avoided ,however, If required all grouting shall be undertaken using a proprietary high strength non-shrink high flow cementitious grout. Concrete foundations for mast structures shall be to grade class C30/37 as a minimum and conform strictly to Customers Design.

All support structure edging shall have a chamfered finish and must not represent a tripping hazard. Design and construction of foundations shall be in accordance with IS EN 1997.

10.2 PILING

If piling is required as part of the foundation design for masts, the Customer shall make their design assessment of the ground conditions based on their Geotechnical Site Investigation Report and further undertake specific site investigations including trials, drillings and testing they consider necessary to guarantee the performance of the piles.

Piles shall be designed to safely support a minimum of two and a half times the specified working load in all cases.

The Customer shall submit to EirGrid for review, design calculations, including calculations to meet specified acceptable settlement (including differential settlement) tolerances supplied by machine / equipment manufacturers, and drawings for proposed piled foundations prior commencement on site. The calculations shall also specify the acceptance criteria for test piles and consider action of pile groups (if applicable).

Piling shall be designed, installed and tested in accordance with IS EN 1997-1 and the "ICE Specification for Piling and Embedded Retaining Walls" published by the Institution of Civil Engineers, London, (latest edition) hereinafter referred to as the ICE Specification and such other Euro-norms as may apply (including BS EN 1536 for bored piles, IS EN 12699 for displacement piling, BS EN 12794 for precast concrete piles, etc) or other approved equivalent standard.

Pile load testing shall be carried out as stated in IS EN 1997-1. The Working pile shall be installed once the pile testing has been successfully completed and the adequacy of the proposed pile design has been demonstrated and documented. The Customer's programme shall include sufficient time set aside for the construction and testing of piles to reflect this requirement.

The following tests shall be carried out on working piles:

- Maintained Load Testing of working piles
- Additional suite of maintained load testing of non-working piles, uplift, etc
- Integrity Testing of All Cast-in-Place Working Piles

The Customer shall ensure that during the work, displacement or damage which would impair either performance or durability does not occur to completed piles.

Piles shall not be bored so close to other piles, which have recently been cast and which contain workable or unset concrete, that a flow of concrete could be induced from or damage caused to any of the piles.

Reinforcement left protruding above pile cut off level shall be protected by wrapping in denso tape and surrounding in lean mix concrete.

10.3 EARTHWORKS /EXCAVATION FOUNDATIONS

The Customer shall ensure the area is assessed and scanned to ensure no water, electricity, telephone, drainage, gas, telecommunications, etc., passing through the site will be affected by the works. As applicable the Customer shall locate any utility and

provide a satisfactory alternative service in full working order to the satisfaction of the landowner or utility provider before altering or removing the existing service.

All poor ground shall be stabilised to achieve adequate bearing capacity ensuring that all formations are adequately protected during excavation works and sealed with blinding or mass concrete as per Customers design. Crossfalls, temporary drains and pumps shall be used to ensure excavations are free of water. Type A and B material in accordance with Transport Infrastructure Ireland (TII- Specification for Road Works) Series 800 shall be used as a base or sub- base for foundation slabs for masts. Fill material ,consolidation and compaction shall comply with TII Series 600. Geotextiles shall have a mass per unit area of 135 grams/m2, a breaking load of 8kN/m and a water permeability of 50 litres/second/m^2.

Permissible tolerances for formation levels are defined below.

Table 2 Permissible Deviation of Formation Levels

Foundation type	Tolerance
Beneath mass concrete foundations	± 25mm
Beneath ground-bearing slabs and R.C. foundations	± 15mm

10.4 CONCRETE

The Customer shall provide concrete to graded class of C30/37 as a minimum and/or conform strictly to the Customers Design. The concrete shall comply with the cement content, exposure class, type, strength class cement and either the free water/cement ration or consistence class constituents as specified by the Customer.

10.4.1 DESIGNED MIX

The Customers Design shall select the mix proportions, the workability, strength, and durability requirements for all foundations. The concrete consistence class is to be chosen depending on the methods of placing, compaction and finishing involved in a particular element.

Designed concrete, either ordinary or special structural concrete, shall be utilised. The concrete compressive strength and exposure classes for the foundations shall be as per Customers Design and clearly shown on the relevant drawings.

The Customers Quality procedures shall maintain records of all concrete mixes which are to be made available to EirGrid on request.

10.4.2 CEMENT

Cement shall be Portland Cement Type CEM I, CEM II or CEM III and shall comply with: IS EN 197-1:2011 “Cement Composition, Specifications and Conformity Criteria for Common Cements”

The manufacturer shall provide certificates of tests on the cement used. Additional tests

shall be carried out on any cement, which appears to have deteriorated either through age, damaged, improper storage or another reason. In any event, the batch of cement, which has been sampled and tested and found not to have complied with the requirements, shall be rejected and removed from the Site. The use of high alumina cement or concrete is prohibited.

10.4.3 CEMENT ADDITIONS

Ground Granulated Blast-furnace Slag (GGBS) can be used as a Type II addition to Normal Portland Cement in concrete in accordance IS EN 206-1:2021 “Concrete: Specification, Performance, Production and Conformity”. Where GGBS is added it replaces Portland Cement on a one-for-one basis.

GGBS shall comply with IS EN 15167-1:2006 “Ground Granulated Blast Furnace Slag for Use in Concrete, Mortar and Grout: Definitions, Specifications and Conformity Criteria” and IS EN 15167-2:2006 “Ground Granulated Blast Furnace Slag for Use in Concrete, Mortar and Grout: Conformity Evaluation.”

All testing and samples shall form part of the Customers Quality documents and on request all concrete mix designs shall be made available to EirGrid in advance of the relevant works.

10.4.4 AGGREGATES

Aggregates shall consist of natural pit sand and washed gravel or approved crushed stone. All aggregates shall be hard, uniform and clean. Aggregates shall conform to IS EN 1262; 2013 and BS EN 13055-1:2002. Single sized coarse aggregates and fine aggregates shall be used for concrete grades above 15N.

For ordinary unreinforced structural concrete of compressive strength classes C8/10, C12/15, C16/20, C20/25 and C25/30 the mix proportions should be selected from a designed concrete mix to be determined by the Customer design.

The compressive strength class of concrete to be used in a particular situation shall be as per Customer’s Design and shall not be less than the appropriate compressive strength class chosen from Table F1 of IS EN 206-1:2021 taking account of the relevant exposure conditions of the OCC site as defined in Table 1 of IS EN 206-1:2021.

10.4.5 BATCHING AND MIXING

Concrete shall be produced in accordance with the procedures of IS EN 206-1:2021, Section 9. Slump tests will be carried out in accordance with IS EN 12350-2:2009. A 300 mm x 200 mm x 100 mm cone shall always be available on site.

10.4.6 READY-MIXED CONCRETE

Ready-mixed concrete shall be carried to site in purpose-made agitators, operating continuously, once mixing is complete. The concrete shall be compacted and in its final position within 2 hours of the introduction of cement to the aggregate

10.4.7 STRENGTH

All sampling and testing of constituent materials shall be carried out in accordance with the appropriate standard. In particular, sampling and testing of fresh and of hardened concrete shall comply with BS EN 12350:2000 and IS EN 12390:2000 respectively, unless this is at variance with this Specification, in particular cement content, consistence class

and free water/cement ratio shall comply with IS EN 206-1:2021. Compliance with the specified characteristic strength shall be based on tests made on cubes at an age of 28 days

10.4.8 TESTING

Frequency of testing shall be for foundations at a rate of one set of 3 No. cubes/per batch. The sampling shall be in accordance with IS. EN 12390 : 2000 : Part 3 with 3 specimen's cubes per sample. First cube to obtain 7-day strength, the 2nd for 28-day strength and third test as required. The rate of sampling shall be :-

a. One set of cubes per 5m3 or 1 truck (Average capacity between 7 to 8m3) on each day that concrete of that grade is used.
b. Two sets of cubes per 20m3 or 3 trucks on each day that concrete of that grade used.
c. Three sets of cubes per 50m3 or 7 trucks on each day that concrete of that grade is used.
d. Four sets of cubes per 70m3 or 10 trucks on each day that concrete of that grade is used.
e. For concrete pours greater than 70m3 the number of sets of concrete cubes to be taken shall be four per 70m3.
f. Concrete Consistence class shall be determined for each batch using tests in accordance with IS EN 12350-2:2009.
g. Air content shall comply with BS EN 12350 7:2009.

10.4.9 CONCRETE -SURFACE FINISH

Formed finishes for concrete shall comply with Customers design. Class of finishes are defined in Table 2 below:-

Table 3-Default Schedule for Formed Surface Concrete Finishes

Type	Finish
F1	No extra requirement
F2	The irregularities in the finish shall be no greater than those obtained from the use of wrought thicknessed square edged boards arranged in a uniform pattern. The finish is intended to be left as struck but imperfections such as fins and surface discolouration shall be made good
F3	The resulting finish, immediately upon removal of the formwork, shall be smooth and of uniform texture and appearance. The formwork lining shall leave no stain on the concrete and shall be so joined and fixed to its backing that it imparts no blemishes. It shall be of the same type and obtained from only one source throughout any one structure. Internal ties and embedded metal parts shall not be used. The Customer shall submit a survey of the as struck finish identifying any minor imperfections prior to any making good, together with a method statement for any proposed remedial work

Unformed surfaces shall be capable of producing the following finishes where required as per

Table 4 below and as specified by the Customer.

Table 4-Uniformed Surface Finishes

Type	Finish
U1	Substructure, slabs- The concrete shall be levelled and screeded to produce a uniform surface to the profile shown on the drawings in the Contract. No further work shall be applied to the surface unless it is used as a first stage for another class of finish
U2	Exposed Substructure, slabs- After the concrete has hardened sufficiently, the Class U1 finish shall be floated by hand or machine sufficiently only to produce a uniform surface free from screed marks.

10.4.10 FORMWORK

The design, detailing, construction and use of Temporary Works is the sole responsibility of the Customer. Design and construction of falsework and formwork shall be in accordance with the following where applicable:

- BS 5975:2008 Code of Practice for Falsework.
- Formwork: A Guide to Good Practice (Concrete Society, 3rd Edition, 2012).
- Formwork Striking Times - Criteria, Prediction and Methods of Assessment (CIRIA Report 136, 1995).
- IS EN 1992-1-1: 2004 Eurocode 2. Design of concrete structures: General rules and rules for buildings.

Co-ordination of the design of the Temporary Works is to be undertaken by means of the IEI Temporary Works Design Certificate (HST1) in keeping with the “Safety Health and Welfare at Work (Construction) Regulations 2006” (Health and Safety Authority).

The formwork shall be so arranged as to be readily dismantled and removed from the cast concrete without shock, disturbance or damage. Shuttering shall be constructed from purpose made mild steel units, from quality planed seasoned timber or from other approved materials lined or treated consistent with the categories of finishes schedule. The formwork to vertical sides of slabs, walls and beams shall be supported by means of suitable external braces, internal metal fasteners or bolts.

Internal metal ties which require to be withdrawn through hardened concrete shall not be used where either face is permanently exposed. Where internal ties are left in, they shall be provided with a mortar cover approved of a least 40 mm or the nominal cover to the reinforcement whichever is the greater. All vertical props shall be fitted with adjustable screws or hardwood folding wedges for adjusting or striking. Void formers expanded polystyrene to BS 3837:2004.

Holes, chases and other openings required for the passage of pipes, conduits, etc, shall

be provided by inserting suitable sleeves, cores and sinking's in the shuttering before placing the concrete. The Customer shall be required to provide as requested by EirGrid full information in regard to the position and size of such openings and chases including the position of bolts, slips and other fastenings.

10.4.11 CONCRETE TRANSPORTING, PLACING AND COMPACTING

Concrete shall be so transported in accordance with the procedures of IS EN 206-1:2021 and placed that contamination, segregation or loss of the constituent materials does not occur.

The manufacturers are required to give a written declaration of conformity to IS EN 206-1:2021 with each delivery.

The Customer shall insure that the time to deliver the concrete from the batching plant and to the framework is not more than 2 hours.

The Customer shall give EirGrid adequate notice (typically 2 days) of the timing of each concrete pour to allow inspections to take place where necessary.

Fresh concrete shall not be placed against in situ concrete that has been in position for more than 45 minutes (or any other period as approved by Customers Design if admixture is used) unless a construction joint is formed.

Concrete, when deposited, shall have a temperature of not less than 5°C and not more than 30°C.

Concrete shall be deposited in horizontal layers to a compacted depth not exceeding 450 mm where internal vibrators are used or 300 mm in all other cases.

Concrete shall not be placed in flowing water nor dropped into place from a height exceeding 1.5 meters. When trunking or chutes are used, they shall be kept clean. All necessary compaction shall be completed within 30 minutes of discharge from the mixer or agitator.

Concreting operations shall not be permitted to displace reinforcement, tendon ducts, tendon anchorages, void formers or formwork, or to damage the faces of formwork. Customer to ensure that competent steel fixers and formwork carpenters shall be in constant attendance during concreting operations.

Concrete shall not be subjected to disturbance between 4 hours and 24 hours after compaction.

10.4.12 STRIKING PERIOD

For mass concrete and structural concrete made with ordinary Portland cement only, in the absence of control cubes the period before striking shall be at least the minimum periods given in Table 4. (These striking times refer to props supporting only the structure directly over.)

Table 5- Minimum period between striking formwork

Location	Minimum Period Before Striking Surface Temperature of Concrete		
	16ºC	7ºC	t°C (any temperature between 0°C and 25°C)
Vertical formwork to foundation bases, columns, walls and large beams	12 hours	18 hours	300/(t + 10) hours
Soffit formwork to slabs	4 days	6 days	100 days / (t + 10)
Props to slabs	10 days	15 days	250 days / (t + 10)

10.4.13 CURING METHODS

Curing Class 3 in accordance with I.S. EN 13670 shall be used unless otherwise specified by the Customer. Concrete shall be protected against harmful effects of weather, including rain, rapid temperature changes, frost, and from drying out.

Accelerated curing with elevated-temperature curing as described below may be used only with Portland cement (CEM I) or sulfate-resisting Portland cement.

The formwork may be generally heated to no more than 20ºC prior to the placing of concrete.

a. Once placing is complete the concrete shall be left for 4 hours without additional heating. The concrete temperature can then be raised at a maximum rate of 10^{O}C per ½ hour.

b. The concrete temperature shall at no time exceed 70^{O}C.

c. The rate of subsequent cooling shall not exceed the rate of heating.

d. Testing samples shall be manufactured and cured under identical conditions to those to which the concrete is subjected.

The use of accelerated curing methods for concrete containing other types of cement or any admixture shall not be permitted.

10.4.14 COLD WEATHER WORK

When concrete is placed at air temperatures below 2^{O}C, the following requirements shall be met:

i. The aggregates and water used in the mix shall be free from snow, ice and frost.

ii. The surface temperature of the concrete at the time of placing shall be at least 5^{O}C and shall not exceed 30^{O}C.

iii. The surface temperature of the concrete shall be maintained at not less than 5^{O}C until the concrete reaches a strength of C4/5N/mm2 as determined by tests on samples that were cured under identical conditions on the structural concrete.

iv. Before placing concrete, the formwork, reinforcement, prestressing steel and any surface with which the fresh concrete will be in contact shall be free from snow, ice and frost.

v. Cement shall not be allowed to meet water at a temperature greater than 60^{O}C.

10.4.15 HOT WEATHER WORK

During hot weather the Customer shall ensure that constituent materials of the concrete are sufficiently cool to prevent the concrete from stiffening in the interval between its discharge from the mixer and compaction in its final position. Cement shall not be allowed to meet water at a temperature greater than 60^{O}C.

10.4.16 DEFECTIVE WORK

Where the finished concrete works or the materials or workmanship in any part of the Works, do not comply with all the relevant requirements of these specifications, testing, sampling, codes or standards, that part of the Works shall be classified as defective work.

All work damaged during construction, frost or inclement weather shall be removed and reinstated.

In all cases, cutting out of defective concrete work shall be carried back to a satisfactory location such as a construction joint before the replacement of the defective work and any work thereby affected is commenced.

Any concrete deemed defective shall be cut out and replaced by the Customer.

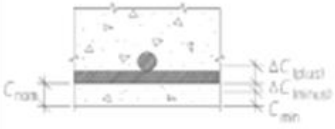
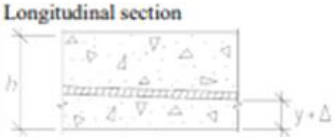
10.4.17 CONCRETE TOLERANCES

The permitted deviations of the dimensioning of the concrete structures area as defined on the Customers Design or shall be as IS EN13670:2009 “Execution of Concrete Structures” for Tolerance Class 1.

10.4.18 COVER TO REINFORCEMENT

Unless otherwise specified by the Customer , tolerances shall be in accordance with IS EN 13670:2009 with permitted deviations as set out in Table 6 below.

Table 6- Permitted Deviations for Cover to Reinforcement

No.	Type of deviation	Description	Permitted deviation Δ
a	Cross-sectional dimensions 	l_i = Length of cross-sectional dimension Applicable to beams, slabs and columns For l_i < 150 mm l_i = 400 mm $l_i \geq$ 2500 mm with linear interpolation for intermediate values	 ± 5 mm ± 10 mm ± 30 mm
b	Location of ordinary reinforcement Cross Section  c_{min} = required minimum cover c_{nom} = nominal cover = c_{min} + | Δc_{dev} | c = actual cover h = height of cross-section Δ = Permitted deviation from c_{nom}	h ≤ 150 mm, h = 400 mm, h ≥ 2500 mm, with linear interpolation for intermediate values	$\Delta_{(plus)}$ = + 5 mm $\Delta_{(plus)}$ = + 10 mm $\Delta_{(plus)}$ = + 20 mm
		All values of h	$\Delta_{(minus)}$ = -5 mm
	Requirement: $c_{nom} + \Delta_{(plus)} > c > c_{nom} - \| \Delta_{(minus)} \|$ Values of $c_{min,dur}$ can be found in DN-STR-03012 Δc_{dev} can be found in National Annex to EN 1992-1-1. See NG 1704.4. NOTE: 1. Permitted plus-deviations for cover to reinforcement for foundations and concrete members in foundations may be increased by 15 mm. The given minus-deviations apply. 2. The definition for $\Delta_{(minus)}$ is not the same as Δc_{dev}.		
c	Lap-joints 	l = Lap length	- 0,06 l
d	Location of prestressing duct Longitudinal section 	y = Intended distance to centreline of duct in plan or elevation	± 5mm

Reinforcement

10.4.19 MATERIAL

All steel reinforcement specified shall comply with I.S. EN 10080 and BS 4449 (Grade B500B or B500C) and shall be cut and bent in compliance with BS 8666 and shall be obtained from a firm holding a valid CARES (or equivalent scheme) certificate of approval for production and supply of steel for the reinforcement of concrete.

10.4.20 HOT ROLLED AND COLD WORKED CARBON STEEL BARS

Hot rolled and cold worked carbon steel bars shall comply with I.S. EN 10080 and BS 4449 except that no bar shall contain a flash weld.

If deemed necessaty stainless steel reinforcing bars shall be in accordance with BS 6744. No on site welded is permitted for Stainless steel.

10.4.21 STEEL WIRE

Steel wire shall only be used in precast concrete elements and shall conform to I.S. EN 10080 and BS 4482 (Ribbed, Grade 500). Steel wire shall have a minimum nominal diameter of 8 mm and shall be obtained from a firm holding a valid CARES (or equivalent scheme) certificate of approval for the production and supply of steel wire.

10.4.22 STEEL FABRIC

Steel fabric reinforcement shall conform to I.S. EN 10080 and BS 4483 (Grade B500A, B500B or B500C) and shall be cut and bent in accordance with BS 8666. Steel fabric reinforcement shall have a minimum nominal bar size of 6 mm (8 mm for Grade B500A) and shall be obtained from a firm holding a valid CARES (or equivalent scheme) certificate of approval for the production and supply of steel fabric reinforcement. Steel fabric reinforcement shall be delivered to site in flat mats or pre-bent. The use of Grade B500A reinforcement for steel fabric is permitted only when it is not accounted for at Ultimate Limit State.

10.4.23 BOND STRENGTH

For hot rolled and cold worked carbon steel bars, and for steel fabric reinforcement, the bond property requirements of BS 4449 shall be complied with based on the surface geometry requirements of that Standard.

For steel wire, the bond property requirements of BS 4482 shall be complied with based on the surface geometry requirements of that Standard.

10.4.24 STEEL REINFORCEMENT – BAR SCHEDULES – CUTTING AND BENDING

The bar schedules are based on the dimensions of the concrete and the nominal cover to the reinforcement shown on the Customers design drawings.

The reinforcement shall be cut and bent within the tolerances given in BS 8666. The mandrel diameter for bending bars shall comply with I.S. EN 1992-1-1. Bending of reinforcement at temperatures below 5°C or more than 100°C shall not be carried out.

10.4.25 REINFORCEMENT FIXING

Reinforcement shall be secured against displacement. The cover to a bar in an outer layer of reinforcement shall be as perTable 6.

Bars in inner layers shall be in close contact with the bars of the outer layer, unless otherwise indicated.

Welding of carbon steel reinforcing bars for fixing purposes shall be as described below in Section 10.4.26.

Cover shall be achieved and fixed by using spacers and chairs which meet the performance requirements of BS 7973-2.

Cementitious Spacer blocks should be factory produced. Site produced concrete or mortar spacers shall not be used. Projecting ends of ties or clips shall not encroach into the concrete cover.

Tying wires shall be 1.2mm diameter stainless steel wire throughout the structure.

The Customer in accordance with their quality management procedures shall carry out a cover measurement survey of all reinforced concrete surfaces within the 24-hour period following the removal of formwork and the results within a further period of 24 hours.

The cover measurement survey shall be carried out on a 500mm grid over the whole concrete structure.

Immediately before concrete is placed around it, reinforcement shall be free from mud, oil, paint, retarder, release agent, loose rust, loose mill scale, snow, ice, grease or any other substance that can be shown to have an adverse chemical effect on the steel or concrete, or to reduce the bond between the steel and the concrete

Laps and joints shall be made only where shown on the Customers design drawings.

The permitted deviation of the lap length from the value stated on the drawings shall be in accordance with Table 6.

Where reinforcing bars are required to be coupled, the coupling system shall have a current Irish Agrément Board Certificate or CARES Certificate of Product Assessment TA1-A or equivalent certificate and shall be sourced, applied and processed from a firm holding relevant valid CARES (or equivalent scheme) certificate of approval.

10.4.26 REINFORCEMENT -WELDING

Welded reinforcement, other than steel fabric reinforcement, shall not be incorporated in the permanent Works.

When required, welding of reinforcing bars shall comply with the requirements of I.S. EN 1992-1-1, shall be carried out in accordance with I.S. EN ISO 17660 and be subject to the demonstration of the satisfactory performance of trial joints (Refer to Section 6.2).

Site welding of stainless-steel reinforcement bars shall not be permitted.

11 STORAGE AND TRANSPORT OF STEELWORK

11.1 STORAGE AND TRANSPORT OF STEEL AND FABRICATED STEELWORK

1. Steel awaiting fabrication for the Works and uncoated steelwork shall be adequately protected from contaminants liable to cause heavy rusting and possibly pitting of the surfaces.
2. Steelwork shall not be loaded for transport until the paint protection system is sufficiently hard for handling.
3. During storage, steelwork shall be kept clear of the ground and shall be laid out or stacked to prevent water or dirt accumulating on or against any of the surfaces.
4. Suitable packings shall be placed between layers of stacked steelwork. When cover is provided it shall be ventilated sufficiently to keep condensation to a minimum.
5. Components weighing less than one tonne shall be kept in a storage area away from their erection point to minimise damage to protective coatings.
6. Lengths of girders and individual steel masts ,lightning masts/rods shall be supported on timber, and precautions taken to prevent damage to their protective coatings and ingress of water.

7. They shall only be positioned adjacent to their erection point immediately before erection. If the planned erection time is delayed significantly the components shall be returned to the storage area.
8. Hot dip galvanized steel and components shall be transported and stored under dry and well-ventilated conditions, to avoid wet storage staining. If stored outdoors, close contact of surfaces of components shall be avoided, and suitable packing shall be placed between components, and to keep the components clear of the ground. Components shall be stored wherever possible at a slight angle to allow water run-off. When cover is provided it shall be ventilated sufficiently to keep condensation to a minimum.
9. If damage to coatings is excessive, or may be difficult to deal with satisfactorily after erection, the Customer shall restore the coatings before erection.

12 Information Required For Masts and Girders

1. Drawings and technical information for acceptance
2. The leading dimensions of each masts or girder.
3. Details of the foundation bolts required for each mast.
4. The height of each bay and such other dimensions as may be required to determine the buckling length of compression members.
5. Assembly drawings
6. Details as to which members, if any, are of high tensile steel.
7. Details of each joint and the length and diameter of the bolts including :-
    a. The minimum distance of the centre of bolt holes from
        i. The end of the member
        ii. Cut edges
        iii. Uncut edges
        iv. An adjacent bolthole
        v. From the inside of an adjacent flange.
    b. The clearance in bolt holes, that is, the difference between the diameter of the hole and that of the bolt.
    c. The tolerance to be permitted in the position of bolt holes as regards:
    d. Their distance apart
    e. Their distance from the datum line
    f. Max and min permissible length of bolt projections beyond the nut.
    g. The maximum permissible length of threaded portion of shank within a loaded member.
8. The tolerance for straightness of members
9. General details of all bends, shaping and cuts.
10. An identification number, preceded by mast or girder type identification, for each member or plate.
11. A schedule showing the quantity, length and section of each member.
12. A schedule showing the quantity, length and diameter for bolts, washers and packs.
13. The position of the ground line.
14. Calculations showing the load, actual stress and permissible stress in each member and the actual and permissible load in each joint.
15. Fully dimensioned drawing of each setting template.
16. A clear indication of how every member and plate is to be fitted with respect to the

adjacent members, the length of every bolt, the thickness of every pack washer, and any other information required for the rapid and accurate assembly of the structures on site.

17. A table showing the quantity, length, section and weight of each piece, including bolts, packs, etc. for each mast or girder.
18. The formula used to determine the permissible stress in compression members or a graph giving this information.
19. Details of corrosion protection
20. Service experience to date including defects history.

1) Details of Quality Assurance system and a short description of the Quality Control including sampling techniques, statistical parameters etc. plus tests carried out on all materials employed.

The above list is not exhaustive and does not preclude the Customer from disclosing any further information pertaining to the steel girders & masts which may be requested by EirGrid.

13 APPENDIX A – CODES AND STANDARDS

CODE REF	DESCRIPTION
IS EN 1991-1 -1-7	I.S. EN 1991-1-4:2005 -EUROCODE 1: ACTIONS ON STRUCTURES - PART 1-4: GENERAL ACTIONS - WIND ACTIONS
IS EN 1993-1-12:2007	EN 1993-1-12:2007 EUROCODE 3 - DESIGN OF STEEL STRUCTURES - PART 1-12:
ISO 12494	ATMOSPHERIC ICING OF STRUCTURES
EN 795	PERSONAL FALL PROTECTION EQUIPMENT
EN 365	PERSONAL PROTECTIVE EQUIPMENT AGAINST FALLS
EN 1990.	EUROCODE - BASIS OF STRUCTURAL DESIGN
EN 1337-6.	STRUCTURAL BEARINGS - PART 6: ROCKER BEARINGS
I.S. EN ISO 129	TECHNICAL PRODUCT DOCUMENTATION (TPD) - PRESENTATION OF DIMENSIONS AND TOLERANCE
BS EN ISO 4157	CONSTRUCTION DRAWINGS
IS EN 10025	HOT ROLLED PRODUCTS OF STRUCTURAL STEELS -
IS EN 10365	HOT ROLLED STEEL CHANNELS, I AND H SECTIONS - DIMENSIONS AND MASSES
IS EN 10210	HOT FINISHED STEEL STRUCTURAL HOLLOW SECTIONS

CODE REF	DESCRIPTION
IS EN 10160	ULTRASONIC TESTING OF STEEL FLAT PRODUCT OF THICKNESS EQUAL OR GREATER THAN 6 MM (REFLECTION METHOD)
EN ISO 9001	QUALITY MANAGEMENT SYSTEMS
IS EN 1090-1	EXECUTION OF STEEL STRUCTURES AND ALUMINIUM STRUCTURES - PART 1: REQUIREMENTS FOR CONFORMITY ASSESSMENT OF STRUCTURAL COMPONENTS
IS EN 1090-2	EXECUTION OF STEEL STRUCTURES AND ALUMINIUM STRUCTURES - PART 2: TECHNICAL REQUIREMENTS FOR STEEL STRUCTURES
IS EN 14399	HIGH-STRENGTH STRUCTURAL BOLTING ASSEMBLIES FOR PRELOADING
IS EN 15048	NON-PRELOADED STRUCTURAL BOLTING ASSEMBLIES
BS 2583	AEROSPACE SERIES. BOLTS, MJ THREADS, IN HEAT RESISTING NICKEL BASE ALLOY NI-PH2601
IS EN 10034	STRUCTURAL STEEL I AND H SECTIONS - TOLERANCES ON SHAPE AND DIMENSIONS
IS EN 10162	COLD ROLLED STEEL SECTIONS - TECHNICAL DELIVERY CONDITIONS - DIMENSIONAL AND CROSS-SECTIONAL
IS EN 10029	HOT-ROLLED STEEL PLATES 3 MM THICK OR ABOVE - TOLERANCES ON DIMENSIONS AND SHAPE
IS EN 10056-1	STRUCTURAL STEEL EQUAL AND UNEQUAL LEG ANGLES
BS EN ISO 14713:2009	ZINC COATINGS. GUIDELINES AND RECOMMENDATIONS FOR THE PROTECTION AGAINST CORROSION OF IRON AND STEEL IN STRUCTURES HOT DIP GALVANIZING
IS EN 1011-1,2	WELDING - RECOMMENDATIONS FOR WELDING OF METALLIC MATERIALS
IS EN ISO 3834-3	QUALITY REQUIREMENTS FOR FUSION WELDING OF METALLIC MATERIAL
IS EN ISO 2560	WELDING CONSUMABLES - COVERED ELECTRODES FOR MANUAL METAL ARC WELDING OF NON-ALLOY AND FINE GRAIN STEELS

CODE REF	DESCRIPTION
IS EN ISO 3834	QUALITY REQUIREMENTS FOR FUSION WELDING OF METALLIC MATERIALS
IS EN ISO 15614-1	SPECIFICATION AND QUALIFICATION OF WELDING PROCEDURES FOR METALLIC MATERIALS - WELDING PROCEDURE TEST
IS EN ISO 9692-1 -2	WELDING AND ALLIED PROCESSES - TYPES OF JOINT PREPARATION - PART 1: MANUAL METAL ARC WELDING, GAS-SHIELDED METAL ARC WELDING, GAS WELDING, TIG WELDING AND BEAM WELDING OF STEELS (ISO 9692-1:2013)
IS EN ISO 9606-1	QUALIFICATION TESTING OF WELDERS - FUSION WELDING
IS EN ISO 14732	WELDING PERSONNEL QUALIFICATION TESTING OF WELDING OPERATORS AND WELD SETTERS FOR MECHANIZED AND AUTOMATIC WELDING OF METALLIC MATERIALS
IS EN ISO 15609-1	SPECIFICATION AND QUALIFICATION OF WELDING PROCEDURES FOR METALLIC MATERIALS - WELDING PROCEDURE SPECIFICATION - PART 1: ARC WELDING
IS EN 10051	CONTINUOUSLY HOT-ROLLED STRIP AND PLATE/SHEET CUT FROM WIDE STRIP OF NON-ALLOY AND ALLOY STEELS - TOLERANCES ON DIMENSIONS AND SHAPE
IS EN ISO 8501-1	PREPARATION OF STEEL SUBSTRATES BEFORE APPLICATION OF PAINTS AND RELATED PRODUCTS — VISUAL ASSESSMENT OF SURFACE CLEANLINESS
IS EN ISO 3834	QUALITY REQUIREMENTS FOR FUSION WELDING OF METALLIC MATERIAL
IS EN ISO 5817	WELDING FUSION-WELDED JOINTS IN STEEL, NICKEL, TITANIUM AND THEIR ALLOYS (BEAM WELDING EXCLUDED) QUALITY LEVELS FOR IMPERFECTIONS
IS EN ISO 17637	NON-DESTRUCTIVE TESTING OF WELDS - VISUAL TESTING OF FUSION-WELDED JOINTS
IS EN ISO 9712	NON-DESTRUCTIVE TESTING QUALIFICATION AND CERTIFICATION OF NDT PERSONNEL
IS EN ISO 17635	NON-DESTRUCTIVE TESTING OF WELDS - GENERAL RULES FOR METALLIC MATERIALS

CODE REF	DESCRIPTION
IS EN ISO 17638	NON-DESTRUCTIVE TESTING OF WELDS - MAGNETIC PARTICLE TESTING
IS EN ISO 3452-1	NON-DESTRUCTIVE TESTING PENETRANT TESTING PART 1: GENERAL PRINCIPLES
IS EN ISO 17640	NON-DESTRUCTIVE TESTING OF WELDS ULTRASONIC TESTING TECHNIQUES, TESTING LEVELS, AND ASSESSMENT
IS EN ISO 11666	NON-DESTRUCTIVE TESTING OF WELDS ULTRASONIC TESTING ACCEPTANCE LEVELS
EN ISO 1461	HOT DIP GALVANIZED COATINGS ON FABRICATED IRON AND STEEL ARTICLES — SPECIFICATIONS AND TEST METHODS
IS EN ISO 3269:2001	FASTENERS. ACCEPTANCE INSPECTION
IS EN ISO 8501-1-3	PREPARATION OF STEEL SUBSTRATES BEFORE APPLICATION OF PAINTS AND RELATED PRODUCTS - VISUAL ASSESSMENT OF SURFACE CLEANLINESS
IS EN ISO 12944-4	PAINTS AND VARNISHES - CORROSION PROTECTION OF STEEL STRUCTURES BY PROTECTIVE PAINT SYSTEMS - PART 1: GENERAL INTRODUCTION
IS EN ISO 11124	PREPARATION OF STEEL SUBSTRATES BEFORE APPLICATION OF PAINTS
BS 7079	GENERAL INTRODUCTION TO STANDARDS FOR PREPARATION OF STEEL SUBSTRATES BEFORE APPLICATION OF PAINTS AND RELATED PRODUCT
BS 381C	SPECIFICATION FOR COLOURS FOR IDENTIFICATION, CODING AND SPECIAL PURPOSES
BS 4800.	COLOUR MATCHING
IS EN 15048-2	NON-PRELOADED STRUCTURAL BOLTING ASSEMBLIES
IS EN 14399	HIGH-STRENGTH STRUCTURAL BOLTING ASSEMBLIES FOR PRELOADING - PART 10: SYSTEM HRC - BOLT AND NUT ASSEMBLIES WITH CALIBRATED PRELOAD
BS 2583	SPECIFICATION FOR PODGER SPANNERS
BS 476	FIRE TESTS - PERFORMANCE

CODE REF	DESCRIPTION
TGD -PART B	TECHNICAL GUIDANCE DOCUMENT PART B FIRE SAFETY (BUILDING REGULATIONS – 2017 AS AMENDED) – IRELAND
DIN VDE 0101	POWER INSTALLATIONS EXCEEDING 1 KV
IS EN: 62305	PROTECTION AGAINST LIGHTNING - ALL PARTS
IS EN 13411-5	TERMINATIONS FOR STEEL WIRE ROPES - SAFETY
BS 7430	CODE OF PRACTICE FOR PROTECTIVE EARTHING OF ELECTRICAL INSTALLATIONS
IS EN 1997-1	EUROCODE 7: GEOTECHNICAL DESIGN
IS EN 12699	EXECUTION OF SPECIAL GEOTECHNICAL WORKS - DISPLACEMENT PILES
BS EN 12794	PRECAST CONCRETE PRODUCTS. FOUNDATION PILES
TII 800 SERIES	TRANSPORT INFRASTRUCTURE IRELAND - SPECIFICATION FOR ROAD WORKS SERIES NG 800 - ROAD PAVEMENTS - UNBOUND AND CEMENT BOUND MIXTURES
TII 600 SERIES	TRANSPORT INFRASTRUCTURE IRELAND - SPECIFICATION FOR ROAD WORKS SERIES 600 - EARTHWORKS
IS EN 197-1:2011	CEMENT - PART 1: COMPOSITION, SPECIFICATIONS AND CONFORMITY CRITERIA FOR COMMON CEMENTS
IS EN 206-2021	CONCRETE - SPECIFICATION, PERFORMANCE, PRODUCTION AND CONFORMITY
IS EN 15167-1:2006	GROUND GRANULATED BLAST FURNACE SLAG FOR USE IN CONCRETE, MORTAR AND GROUT
IS EN 1262	SURFACE ACTIVE AGENTS
BS EN 13055	LIGHTWEIGHT AGGREGATES
IS EN 12350	TESTING FRESH CONCRETE
IS EN 12390	TESTING HARDENED CONCRETE
BS 5975:2008	2008 CODE OF PRACTICE FOR FALSEWORK.
BS 3837:2004	EXPANDED POLYSTYRENE BOARDS
I.S. EN 13670	IRISH NATIONAL ANNEX TO I.S. EN 13670:2009 - EXECUTION OF CONCRETE STRUCTURES

CODE REF	DESCRIPTION
I.S. EN 10080	STEEL FOR THE REINFORCEMENT OF CONCRETE - WELDABLE REINFORCING STEEL - GENERAL
BS 4449	STEEL FOR THE REINFORCEMENT OF CONCRETE - WELDABLE REINFORCING STEEL - BAR, COIL AND DECOILED PRODUCT - SPECIFICATION
BS 8666	SCHEDULING, DIMENSIONING, BENDING AND CUTTING OF STEEL REINFORCEMENT FOR CONCRETE. SPECIFICATION
BS 4482	STEEL WIRE FOR THE REINFORCEMENT OF CONCRETE PRODUCTS - SPECIFICATION
BS 4483	STEEL FABRIC FOR THE REINFORCEMENT OF CONCRETE. SPECIFICATION
I.S. EN 1992-1-1	EUROCODE 2: DESIGN OF CONCRETE STRUCTURES
BS 7973-2	SPACERS AND CHAIRS FOR STEEL REINFORCEMENT AND THEIR SPECIFICATION - PART 2: FIXING AND APPLICATION OF SPACERS AND CHAIRS AND TYING OF REINFORCEMEN
I.S. EN ISO 17660	WELDING - WELDING OF REINFORCING STEEL

Codes and Standards listed as they appear in the Specification.