

OVERHEAD LINE SUPPORT FOUNDATIONS

This document is for internal and contract specific use only.

Disclaimer

NGG and NGET or their agents, servants or contractors do not accept any liability for any losses arising under or in connection with this information. This limit on liability applies to all and any claims in contract, tort (including negligence), misrepresentation (excluding fraudulent misrepresentation), breach of statutory duty or otherwise. This limit on liability does not exclude or restrict liability where prohibited by the law nor does it supersede the express terms of any related agreements."

TABLE OF CONTENTS

PURPOSE AND SCOPE.....	1
PART 1 – PROCEDURAL	2
1 DESIGN	2
2 MATERIALS [PART 1 CLAUSE 8.7]	11
3 CONSTRUCTION AND INSTALLATION [PART 1 CLAUSE 8.8]	12
4 CORROSION PROTECTION	18
5 QUALITY ASSURANCE	19
6 FORMS AND RECORDS	24
PART 2 - DEFINITIONS AND DOCUMENT HISTORY	25
7 DEFINITIONS	25
8 REFERENCES	26
9 AMENDMENTS RECORD	28
10 IMPLEMENTATION	28
PART 3 - GUIDANCE NOTES AND APPENDICES	29
APPENDIX A - FOUNDATION GEOTECHNICAL DESIGN PARAMETERS	29
APPENDIX B - SITE INVESTIGATION – GUIDANCE DETAILS.....	30
APPENDIX C - CONTAMINATED LAND INVESTIGATION – GUIDANCE DETAILS.....	34
APPENDIX D - NOTIFICATION AND HOLD POINTS.....	38
APPENDIX E - ENGINEERING DOCUMENTS TO BE SUBMITTED BY THE CONTRACTOR.....	39

PURPOSE AND SCOPE

This document forms part of a suite of documents which define National Grid Transco's (NGT) functional and performance requirements for new and modified plant and equipment.

This Specification defines NGT's requirements for the design including site investigation, construction and testing of foundations for overhead line supports (lattice steel towers and/or steel poles) and is applicable to new construction, and upgrading of existing foundations.

For overhead lines designed in accordance with the requirements of BS EN 50341-1 (hereinafter referred to as Part 1) and BS EN 50341-3-9 (hereinafter referred to as Part 3-9), the appropriate cross-references to the applicable clauses in Part 1 and Part 3-9 have been included, in brackets, in the text of this Specification.

This document replaces NGTS 2.10 Section 502 for design of new foundations or where strengthening is required as a result of a strength assessment against NGTS 2.10 Section 502. It is an interim issue and is subject to review by NGT following a programme of research and development into the strength co-ordination between the supports and their foundations, the corresponding foundation strength (material) factors and the characteristic strength of the foundations.

PART 1 – PROCEDURAL

1 DESIGN

1.1 General [Part 1 clause 8.2]

The design of all foundations shall be in accordance with the requirements of this Specification and shall be the responsibility of the Contractor. Foundations shall be designed and installed for a minimum service life of 80 years. Compliance with the requirements of BS 8110-1, or DD ENV 1992-1-1 and BS EN 206.1 / BS 8500 is deemed to satisfy the service life specified.

When required by the Contract Specification the investigation of the ground conditions and the determination of the corresponding geotechnical design parameters shall be carried out by suitable methods and on an adequate scale to enable the selection of the appropriate foundation type to be made for each support position. Any subsidence or failure, due in the opinion of the Engineer to insufficient care having been taken in the site investigation, in the interpretation of the results of the site investigation, the design of the foundation, or in the installation of the foundations shall be the Contractor's responsibility.

In areas where ground subsidence is likely to occur, the Contractor shall, if necessary, carry out modifications to the support foundations as agreed by the Engineer. Collar or tie beams between individual footings shall not be used unless specifically authorised by the Engineer. The Contractor shall not be held responsible for the failure of supports and foundations arising from adjacent mineral extraction subsequent to the construction of the overhead transmission line. The Contractor shall, however, be held liable for any lack of foundation or support stability due to causes other than subsidence resulting from subsequent mineral extraction, or construction or developments by others outside the control of the Contractor.

The Contractor shall be responsible for obtaining agreement from the Engineer for the type and design of the foundations installed. As a general requirement no site work can commence before such agreement has been obtained. This is a **Hold Point**.

1.2 Types and uses

Reference should be made to the Contract Specification for details of specific foundation requirements.

1.3 Loads acting on foundations [Part 1 clause 8.4]

Support foundations shall be designed to resist the specified ultimate limit state loadings (actions) imposed on them, which may include uplift, compression and overturning. Allowances shall be made in the design for hydrostatic pressure, variations in the ground water level, cyclic loadings and wind induced vibration of the support members.

Reference should be made to the Contract Specification for details of the applied foundation loading and details of the serviceability limit state requirements for steel pole supports.

1.4 Partial load and Strength factors [Part 3-9 Table 4.2.11(b)/GB.1]

Unless it is stated to the contrary in the Contract Specification, it shall be assumed that all applied foundation loadings specified by NGT are inclusive of the partial load factor (γ_v).

Unless it is stated to the contrary in the Contract Specification, it shall also be assumed that the applied foundation loading is inclusive of the foundation partial strength (material) factor (γ_m) of 1.35.

Unless it is stated to the contrary in the Contract Specification, it shall be assumed that the partial factor for permanent actions (self weight) shall be taken as the more onerous of 1.1 or 0.9.

The foundation partial strength factor takes into consideration the concept of strength co-ordination between the support and its foundation based on the principles outlined in IEC 60826, whereby it is assumed that the foundation will fail after the support. The partial strength factor quoted is based on the assumed characteristic strength of the support and the foundation, the corresponding coefficients of variation, the number of components subjected to the critical load and the quality level of installation. For ease of application it is convenient to apply the foundation strength factor to the applied loading,

1.5 Site investigation [Part 1 clause 8.3]

When required by the Contract Specification the Contractor shall undertake the site investigation, which shall be carried out by suitable methods and on adequate scale to enable the selection of the appropriate foundation to be made for each support position.

All site investigation shall be undertaken in accordance with the recommendations of BS 5930 and all subsequent laboratory testing in accordance with the requirements of BS 1377. Due cognisance shall also be taken as appropriate of the recommendations of the following publications, ICE 'Site investigation in construction', CIRIA Special publication 32 and BS 10175.

Details of the Contractor's desk top study, the risks identified and his proposals for the ground investigation shall be submitted to the Engineer for his agreement prior to work commencing on site. This is a **Hold Point**.

Commencement of the ground investigation shall be a **Notification Point**.

The ground investigation factual report shall be forwarded to the Engineer within an agreed period after completion of the site work.

For further guidance on NGT's requirements for site investigation including the investigation of contaminated land reference should be made to Appendices B and C of this specification.

1.6 Geotechnical design [Part 1 clause 8.5.2]

Unless stated to the contrary in the Contract Specification, the geotechnical design of the foundation shall be based on the foundation's characteristic strength at a 5 percent exclusion limit. The design methods used shall be based on accepted codes of practice, any relevant literature or by methods that have been used with proven practical experience by the Contractor and agreed by the Engineer.

Prior to their use, it shall be established whether the theoretical geotechnical design model determines the nominal ultimate foundation design strength or the foundation's characteristic strength. If the former applies, the characteristic strength shall be determined by the application of the appropriate probabilistic strength reduction factor.

For the purpose of this specification it shall be assumed that for concrete spread foundations designed using the 'frustum' method for uplift resistance, the characteristic strength is equivalent to the nominal ultimate foundation design strength. For all other types of foundations the Contractor shall be responsible for determining the characteristic strength of the foundation.

The Contractor shall submit his proposed design methodology to the Engineer prior to commencing the detailed design of the foundations. This is a **Hold Point**. Where applicable the proposed method of installation and the associated QC procedures shall also be submitted.

Unless stated to the contrary in the Contract Specification full-scale load tests, both design and proof tests, shall be undertaken on specified foundations. Design tests shall be undertaken to establish both geotechnical design parameters and to verify compliance of the foundation design with the Contract Specification. Proof test shall be undertaken to verify that satisfactory levels of workmanship are maintained on the project.

1.7 Geotechnical design parameters [Part 3-9 clause 8.5]

Unless it is stated to the contrary in the Contract Specification, the geotechnical design parameters specified in Appendix A, Tables A1 and A2, shall be used for tender design purposes only. Contract design shall be based on the results of the site investigation.

1.8 Design principles

1.8.1 General

The following basic design principles shall be taken into consideration during the geotechnical and/or the structural design of the foundations.

The maximum displacement of the foundation under ultimate applied uplift loading due to normal climatic conditions (i.e. high wind, combined wind and ice or extreme ice) shall not exceed 10 mm, except for tension support drilled shaft foundations in cohesive soil where the displacement shall not exceed 7 mm.

In determining the ultimate ground pressure under ultimate compression loading, due consideration shall be taken of the nature of the applied loading whether permanent or transient and the strata beneath the founding level which may adversely affect settlement or cause shear failure. The settlement of the foundation under ultimate applied compression loading due to normal climatic conditions (i.e. high wind, combined wind and ice or extreme ice) shall not exceed 10 mm.

1.8.2 Separate foundations

1.8.2.1 Concrete spread foundations

This foundation takes the form of a truncated concrete pyramid surmounted by a chimney. Alternatively, the truncated pyramid may be replaced and/or used in conjunction with a reinforced concrete pad. The included angle between the horizontal and the sides of the pyramid shall not exceed 70°.

Uplift resistance is assumed to be provided by the weight of foundation, the weight of the soil contained within the assumed failure surface and the shear strength mobilised along the failure or slip surface. Due consideration shall be taken of buoyancy effects and reduced backfill densities.

For design under compression loading the area of the base is determined by the design ground bearing pressure under ultimate limit-state loading. In assessing the bearing pressure beneath the foundation, the additional weight of the foundation over the displaced soil shall be multiplied by the appropriate partial factor for permanent actions (reference clause 1.4).

Reinforced concrete chimneys for use with spread foundations shall be designed to withstand the maximum horizontal resultant residual shear component, with due allowance given, where appropriate, to the lateral (passive) earth resistance of the backfill or surrounding soil. A parabolic distribution of pressure may be assumed. A minimum allowance of 750 mm shall be considered for seasonal effects and/or depth of material not suitable for providing lateral support. The residual shears are considered to act at the lowest bracing point of the tower.

No allowance shall be made for the nominal strength of concrete in tension and the stub shall not be considered as providing any part of the tensile area of reinforcement.

In weak homogenous rock, where the long term stability of the rock can be assured, an alternative type of foundation may be used where a nominally reinforced concrete block is cast-in-situ against the undisturbed rock. A nominal (150 mm) undercut should be provided at the lower edge if possible. Uplift resistance is assumed to be provided by the skin friction developed at the concrete-rock interface and any soil-rock overburden.

1.8.2.2 Anchor foundations

The foundation shall comprise a reinforced concrete pad at, or below ground level in conjunction with suitably designed ground anchorages. The design of the ground anchorages shall be in accordance with the recommendations of BS 8081.

Where the arrangement of the anchors is such that the horizontal shear loads (both leg and residual) are not designed to be wholly or partially resisted by the anchors, such horizontal loads, or balance thereof shall be catered for in the design of the concrete pad.

The design of the anchor cap chimney shall be in accordance with the requirements of clause 1.8.2.1

1.8.2.3 Drilled shafts

Drilled shaft foundations shall comprise a large diameter reinforced concrete single parallel shaft.

The average skin friction or adhesion per unit area of the shaft shall be determined from either the soil properties measured on samples in an undrained triaxial compression test or in-situ field tests. The average value shall be taken over the effective length of the shaft. A minimum allowance of 750 mm shall be considered for seasonal effects and/or depth of material not suitable for providing lateral support.

To allow for tolerances in the location of the stub an eccentricity of 2.5° in the hip leg slope shall be allowed for in the determination of the applied foundation loading.

The design of the main reinforcement shall be adequate for both combined axial and bending forces over the complete length of the shaft.

1.8.2.4 Piled foundations

Piled foundations may comprise multiple raked or vertical piles interconnected at or below ground level by a reinforced concrete cap or by single large diameter vertical pile. Alternatively, single or multiple raked open-ended steel tube piles may be used.

Vertical piles shall be used when ground settlement is likely to impose unacceptable bending stresses on raked piles, or where the type of pile cannot be installed raked.

Ground beams shall be provided where the applied horizontal shear forces cannot be resisted wholly or partially by the lateral resistance of the piles and/or pile cap. In addition to the loading derived from the support, ground beams shall be designed to resist a 50 kN wheel load unless advised to the contrary in the Contract Specification.

In assessing the compression loading on the piles, the weight of the pile cap, soil overburden and ground beams shall be multiplied by the appropriate partial factor for permanent actions (reference clause 1.4). In determining the uplift loading on the piles the actual weight of the pile cap, soil overburden and ground beams shall be multiplied by the appropriate partial factor for permanent actions (reference clause 1.4). Due allowance shall be made for buoyancy effects where applicable.

For piled foundations where the average design value of the standard penetration test 'N' is less than 5 or the average design value of the undrained shear strength is less than 20 kN/m², the minimum dead weight of the piles, pile cap and ground beams (if any) shall not be less than 28 percent of the applied loading.

The design of the pile cap chimney shall be in accordance with the requirements of clause 1.8.2.1.

1.8.2.5 Micro piles

Micro piles for use as the main foundation element or for foundation refurbishment / upgrading shall be designed and constructed in accordance with the requirements of this specification and the recommendations of the ICE 'Specification for Piling and Embedded Retaining Walls' unless otherwise agreed by the Engineer.

Design compression and uplift loads on the piles shall be in accordance with the requirements of clause 1.8.2.4 of this specification.

For bored cast-in-situ micro piles a factory applied double protection system shall be provided to the central pile reinforcement comprising an impermeable sheath in conjunction with an inner cement grout annulus. A minimum external cement grout cover of 20 mm shall be provided. For self-drilling hollow core grouted piles a minimum grout cover of 50 mm shall be provided. Alternatively, the use of austenitic stainless steel bars to BS 6744 with a minimum of 20 mm grout cover in soil and 10 mm grout cover in rock may be used.

1.8.3 Compact foundations

1.8.3.1 Directly embedded steel poles

The applied loading is resisted primarily by the lateral resistance of the soil, in conjunction with the vertical side shear resistance and base axial and shear resistance. The effects of the backfill soil annulus surrounding the pole, i.e.: method of backfilling, backfill density and the overall excavation diameter shall be taken into account in the geotechnical design model.

Backfill material may be native soil, imported granular material, or flowable backfill, e.g. sand, cement, and pulverised-fuel ash.

1.8.3.2 Drilled shaft foundations

Drilled shaft foundations for single steel poles shall comprise a large diameter reinforced concrete parallel shaft. The applied loading is resisted primarily by the lateral resistance of the soil, in conjunction with the vertical side shear resistance and base axial and shear resistance. Normal design practice is to consider the drilled shaft as a rigid body and not a long flexible pile where the resistance to the applied loading is only provided by the lateral resistance of the soil.

1.8.3.3 Piled foundations

Single piles shall not be used as a compact foundation for tension supports. For details of the corresponding design principles reference should be made to clause 1.8.2.4 of this specification.

1.8.3.4 Raft foundations

Raft foundations for wide base lattice towers shall only be used in areas subject to mining settlement, or in very poor ground where piling is not possible.

1.8.4 Support – Foundation interconnection

1.8.4.1 Stub and cleats [Part 3-9 clause 8.7 GB1]

Where stub angles are cast in concrete to form the support – foundation interconnection they shall be fitted with angle cleats sufficient to transfer 100 percent of the uplift load into the concrete. In the case of compression loads, the cleats shall be designed to transfer at least 50 percent of the load, the remainder being transferred in bond between the stub and the concrete. Unless otherwise agreed all cleats shall be cast at an adequate distance into the pyramid, pad or cap to ensure a 100 percent transfer of the uplift load.

The connection point of the lowest hole of the bracing with the stub shall be not less than 100 mm above the top of concrete, i.e. 250 mm above ground level, thereby eliminating the need for a separate concrete cap (muff). The overall stub length shall allow for a 300 mm differential in ground level between adjacent stubs as a standard. Non-standard leg or concrete extensions will be required where the ground level variation between adjacent support legs exceeds 300 mm.

The provision of separate concrete caps (muffs) shall be subject to the agreement of the Engineer. This is a **Hold Point**.

1.8.4.2 Holding-down bolts [Part 1 clause 7.4.6.7 and Annex K Clause K6]

Unless stated to the contrary in the Contract Specification, holding-down bolts shall be designed in accordance with the requirements of Part 1 clause 7.4.6.7 and Annex K clause K.6.

1.9 Structural design [Part 1 clause 8.7, Part 3-9 clause 8.7]

Reinforced concrete design of foundations shall be in accordance with the requirements of either DD ENV 1992-1-1 (EC2) or BS 8110 unless otherwise stated in this Specification.

The bond between galvanised steel stub angles and the concrete shall be taken as 1.1 N/mm².

Unless calculations show that a greater area of reinforcement is required, the minimum area of reinforcement in pile caps shall be 875 mm²/m in all directions (top, bottom and sides).

All structural steelwork (excluding directly embedded steel poles) and reinforcement, including links and stirrups, below ground level shall be completely encased in concrete to ensure a minimum cover as specified in Table 1. Such cover shall exist from the point of entry into the concrete base to either 150 mm above final ground level, or to the top of the concrete leg extension.

Aggressiveness Design Sulphate class (1)	Reinforcement (mm)	Stub steelwork, or reinforcement designed as 'stub' steelwork (mm)
DS-1 to DS-3	50	100
DS-4 to DS-4m	75	125

Table 1 – Nominal Concrete cover

Note:

- (1) Reference BS 8500-1 Table A.2
- (2) Nominal concrete cover is inclusive of the fixing tolerances.

For concrete cast directly against the ground the specified cover shall be increased by 25 mm.

1.10 Concrete design mixes [Part 1 clause 8.7]

1.10.1 General

The Contractor shall be entirely responsible for the control of the quality of the concrete mixed and placed in the Works. Before the commencement of any concrete work, the Contractor shall submit to the Engineer, a complete specification giving details of the materials used, sources of supply and QC requirements including, if necessary, trial mixes and works' tests. This is a **Hold Point**.

To ensure the durability of the concrete the requirements specified in Table 2 shall be adhered to with regard to strength class and/or characteristic strength, type of cement, minimum cement content and maximum free water/cement ratio.

Concrete structural design standard	BS 8110 or EC2	
Foundation type	Separate spread footings, pile caps, anchor foundation caps, monoblocks and rafts	Drilled shafts, cast-in-situ piles and c.f.a piles
Concrete performance criteria	BS EN 206-1, BS 8500-1 & BS 8500-2	
Concrete designation (1)	Designated	Designed
Strength class	N / A	C28/35
Designated concrete (2)	FND2 to FND4M** as appropriate (3)	N / A
Permitted types of cement and combinations (4)	SRPC, CIIB-V ^c and CIIB	

Table 2 - Concrete mix parameters

Notes:

- (1) As per BS 8500-1
- (2) As per BS 8500-1 Table A.7.
- (3) The actual designated concrete to be used is dependent on required level of sulphate and acid resistance required. Minimum requirements design sulphate class DS-3 with natural soil and static water pH >3.5, i.e. the Aggressive Chemical Environment for Concrete (ACEC) class AC-2s, reference BS 8500-1 Table A.2.
- (4) As per BS 8500-1 Table A.17.

In the determination of the appropriate Design Chemical (DC) classification reference should also be made to recommendations of BRE Special Digest 1. For both Designated and Designed concretes the structural performance level shall be taken as 'Normal' (ref. BS 8500-1 Table A.3). In addition, the only Additional Protective Measures (APMs) to be considered shall be APM1(ref. BS 8500 Table A.5), unless otherwise agreed by the Engineer.

The consistence class for designated concrete shall be S3, unless otherwise agreed by the Engineer.

For designed concrete the following exposure classes shall be assumed, unless otherwise agreed by the Engineer:

- a) Carbonation (XC classes) XC3 and XC4

- b) Chlorides (XD classes) XD2
- c) Freeze/thaw attack (XF classes) XF1 or XF3 as appropriate
- d) Chemical attack (minimum requirements) design sulphate class DS-3 with natural soil and static water pH >3.5, i.e. ACEC-class AC-2s.

Notes:

- (1) Freeze/thaw attack class XF3 only applies to pile caps above ground level.

1.10.2 Requirements for designed concrete

The Contractor shall submit for the Engineer's agreement prior to the supply of any designed concrete details of his proposed concrete composition including his determination of the ACEC-class and associated DC class, maximum water/cement ratio, minimum cement content, consistence class etc., together with details of the proposed producer's production control including the initial test results if applicable.

1.10.3 Muff concrete

Where muffs are to be refurbished on existing towers, these may be constructed using a standardized prescribed mix in accordance with the requirements BS 8500-1.

The mix proportions of the prescribed concrete, when used as an alternative for muff concrete, shall be as detailed in Table 3. The mass of materials with added water will be sufficient to produce approximately 1 m³ of concrete

Standardized prescribed concrete (see Table A.9 BS 8500-1)	Maximum aggregate size (mm)	Cement (1) (kg)	Total aggregate (kg)	Fine aggregated as a mass fraction of total aggregate (%) (2)
ST5	20 or 22.4	375	1800	Grading limits CP 35 to 40 Grading limits MP 30 to 40 Grading limits FP 25 to 35

Table 3 – Standardized prescribed concrete mix parameters (muff concrete)

Notes:

- (1) Cement shall be SRPC to BS 4027, cement grade 42.5N LA.
- (3) Slump class S2.

1.11 Earthing system

1.11.1 Touch and Step Potential

Touch and step potentials at the tower base shall be controlled in accordance with NG guidance. Further advice shall be sought from Asset Strategy, Asset Policy. This is a **Hold Point**.

1.11.2 Foundations

Steel reinforcement within the footing shall, where practicable, be connected to the tower leg.

For the particular case of tubular steel encased foundations a direct electrical connection from the tower leg to the casing shall be made within the concrete in-fill.

At substations, connection shall be made from at least two legs of the terminal support to the substation earthing mat.

1.12 Foundation refurbishment and upgrading

Reference should be made to the Contract Specification for details of the foundation refurbishment and /or upgrading to be undertaken.

1.13 Design submissions

The Contractor shall submit the following design submissions to the Engineer as appropriate:

- a) Design Methodology, i.e. the theoretical basis including: the proposed method of determining the foundation's characteristic strength, the proposed method of installation and Q.C. procedures;
- b) Geotechnical report, which shall include, as a minimum, the desk top study, factual and interpretative reports and the development of engineering properties required for the foundation geotechnical design;
- c) Foundation design calculations, which shall include as a minimum a cross-reference to the geotechnical report, applied loading calculations, foundation general arrangement drawing and the stub or holding-down bolt drawing;
- d) Foundation general arrangement drawings, which shall include, as a minimum, the geotechnical design parameters, concrete mix design parameters and cross-reference to the design calculations, stub or holding down bolt details, reinforcement schedule etc. Details of the stub setting and excavation plus any chimney extensions shall also be included. For piled foundations details of the piles shall be included e.g. type, length, diameter, etc. Drawings for reinforcement shall be fully dimensioned and include both the quantity and mass per item;
- e) Bar bending schedules (information only);
- f) Foundation formwork drawings (information only);
- g) Foundation setting level diagrams, which shall be prepared at a scale of 1:200 (horizontally and vertically) and shall show the foundation excavation and setting levels of the two diagonals (drawn such that they meet at the tower centre peg). In addition, a record of the applicable foundation design, leg and body extensions and tower centre peg co-ordinates plus the tower setting level shall be shown;
- h) Foundation setting templates;
- i) Earthing system design;
- j) Foundation testing procedures.
- k) Temporary works design including support backstay calculations (if applicable).

1.14 Installation criteria

The Contractor shall prepare a schedule for construction purposes which clearly indicates, for each support position, the soil and/or rock type, ground water level, the type of foundation to be installed at that position, the concrete mix, the backfill material to be used and

thickness of any directly buried steelwork. The schedule shall demonstrate the basis for selection, taking into consideration the following items:

- a) The results of the site investigation; and
- b) The results of any full scale foundation design tests; and
- c) The foundation design criteria,

This schedule shall be submitted to the Engineer, prior to any foundation installation commencing. This is a **Hold Point**.

2 MATERIALS [PART 1 CLAUSE 8.7]

2.1 Concrete

All materials used in the production of concrete, including all admixtures shall be in accordance with the requirements of BS 8500-2.

2.2 Reinforcement

High yield reinforcement shall be hot rolled deformed bars or cold worked deformed bars to BS 4449 and shall have a type 2 bond classification. Mild steel reinforcement shall be plain hot rolled bars to BS 4449.

Details of type and grade of reinforcement for micro piles shall be submitted to the Engineer. This is a **Hold Point**.

Steel fabric or wrapping fabric shall be to BS 4483.

Where specified fibre enhanced concrete, shall contain fibres manufactured from 100 percent virgin polypropylene fibre and designed to achieve maximum distribution and freedom from clustering in the mix.

2.3 Ancillary materials

2.3.1 Reinforcing bar couplers

The use of proprietary bar couplers to extend the reinforcement will be permitted. Details of the coupling system shall be submitted to the Engineer prior to their use. This is a **Hold Point**.

2.3.2 Spacers

Dense sand/cement mortar spacing blocks shall be of low permeability having at least similar strength, durability and appearance to the surrounding concrete.

Details of patent spacers shall be submitted to the Engineer.

2.3.3 Tying wire

Tying wire shall be 1.6 mm black annealed mild steel wire for un-coated mild or high yield steel reinforcement

2.4 Ground anchorages

All the materials used in the installation of ground anchorages shall be in accordance with the requirements of BS 8081.

2.5 Piles

All materials used in the manufacture of pre-cast reinforced, pre-stressed concrete piles, pre-cast reinforced concrete segmental piles and steel piles shall be in accordance with the requirements of the ICE 'Specification for Piling and Embedded Retaining Walls'.

2.6 Steel pole embedded sections and stub steelwork [Part 1 clause 7.2.1]

All embedded sections of steel poles, stub steelwork and bolts shall comply with the requirements of TS 3.4.16, except that bolts and nuts used for cleat attachment may be Grade 8.8 to BS EN 24014 and BS EN 24032.

2.7 Holding-down bolts [Part 1 clause 7.2.4]

All holding-down bolts shall comply with the requirements of clause 7.2.4 of Part 1, unless specified to the contrary in the Contract Specification.

2.8 Refurbishment of foundations

In the selection of the appropriate repair system due cognisance shall be taken of the recommendations contained in Cigré Brochure No. 141.

3 CONSTRUCTION AND INSTALLATION [PART 1 CLAUSE 8.8]

3.1 General

All workmanship shall be in accordance with the requirements of this specification, the appropriate British Standard and local site instructions, including the appropriate Health and Safety and environmental requirements.

3.2 Installation method statement

The Contractor shall submit to the Engineer a comprehensive method statement giving sequential details of his proposed installation method. The method statement shall include, but not be limited to, the following details:

- a) Method of excavation / installation (for all types of foundations) and dealing with water; and
- b) Method of heating, welding and site bending of reinforcement; and
- c) Method of placing concrete, including grouting; and
- d) Method of back-filling and compacting; and
- e) Quality Control procedures; and
- f) Risk assessments including cross-reference to design checks on foundations under temporary construction loadings or during refurbishment and/or upgrading.

As a general requirement no foundation installation can commence before the agreement to the method statement by the Engineer has been obtained. This is a **Hold Point**.

3.3 Site working area

The Contractor will be restricted to a specified maximum working area at each support site, and shall, when required, mark this area out and display clearly visible warning signs at regular intervals. Individual excavations shall be properly secured with 'Heras' fencing or similar in accordance with the requirements of the Contract Specification.