

Donegal County Council

Dunree Shed

Works Requirements Vol A2

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0594-MFA-WRE-A2-600-001 Civil/ Structural

**DESIGNING A
SUSTAINABLE
FUTURE**



CIVIL | STRUCTURAL | ROADS | PROJECT MANAGEMENT

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1 PRODUCT SPECIFICATION AND STANDARDS – GENERAL

1.1 QUALITY OF MATERIALS

The whole of the materials shall be the best of their respective kinds, and shall in every case be subject to the approval of the Employer's Representative whose decision in all matters appertaining as to quality and suitability of materials and workmanship shall be final and binding. So far as is practicable, the origin of goods and materials used in the Works shall be Ireland, or one of the other member states of the European Union.

All materials shall be new (unless the Contract allows otherwise) and of the best quality and shall be transported, handled, and stored in such a manner as to prevent deterioration, damage or contamination. As soon as possible after the contract is awarded, the Contractor shall inform the Employer's Representative of the names of the suppliers from whom he proposes to obtain materials, but he shall not place orders for such materials without the approval of the Employer's Representative, which approval may be withheld until samples have been submitted and satisfactorily tested.

When proprietary products are specified similar products from other manufacturers may be accepted at the discretion of the Employer's Representative provided, they are at least equal in quality to those specified. Samples shall be taken in accordance with the appropriate standard where applicable. The materials subsequently supplied shall conform to the quality of samples that have been approved by the Employer's Representative. Names of additional suppliers and sources may be submitted by the Contractor during the execution of the Contract, but no source of supply shall be changed without the Employer's Representative's approval.

All materials or substances shall comply with current applicable Irish Standards (IS or ISEN) and current applicable Irish Codes of Practice, and where there are no applicable Irish Standards or Codes of Practice, then the materials or substances shall comply with the current applicable British Standards (BS or BSEN) and Codes of Practice. No materials or substances shall be used which are known to be deleterious to health or safety or the durability of the Works in the particular circumstances in which these materials or substances are to be used.

Nothing stated in this Specification is to be construed as discriminating against products and materials manufactured in any of the Member States of the European Union.

Where items to a particular national standard of a Member State of the European Union are called for, this requirement shall be read as including items to a relevant international standard, or the relevant national standard of any Member State of the European Community that provides an adequate guarantee of safety and suitability.

Where items certified by the National Standards Authority of Ireland as complying with an Irish Standard are called for, the provisions of Circular Letter BM2/87 and Circular Letter BC 14/92 shall apply, i.e. the requirement shall be read as either certified by the National Standards Authority of Ireland as complying with the Irish Standard and shall bear the Irish Standard Mark, or shall be certified as complying with the relevant national standard of another Member State of the European Union, which provides an equivalent guarantee of safety and suitability – certification to be by the National Standards Authority of Ireland.

All products, unless there is a specific derogation, shall comply with the Construction Products Regulations, and shall bear the CE mark when delivered to site. The contractor shall prepare a spreadsheet to demonstrate compliance with the Construction Products Regulations for every product used on the project. This spreadsheet shall be kept up to date right through the project and copied to the Employers Representative at each progress meeting and when otherwise requested. The contractor shall not accept delivery of any products without first getting a copy of the certification showing that the product complies with the Construction Products Regulations, including the harmonised technical specifications, the specific requirements of this contract including works requirements, specifications and drawings, the minimum requirements in the National Annexes and Standard Recommendations, compliance with the Building Regulations in relation to use of proper materials that are fit the use for which they are intended and conditions of use, and the appropriate Declaration of Performance.

1.2 PRIORITY OF STANDARDS

The primary standard for all materials, insofar as the standard exists, shall be the European Standard (EN) as published by CEN, or as transposed in Ireland as ISEN. The following order of priority shall apply to the interpretation of standards:

- ISEN – if such a standard has been published for the material, this shall be the standard specification for the material. If no ISEN has been published for the material, then;
- EN shall apply. If no EN has been published for the material, then;
- IS shall apply. If no IS has been published for the material, then;
- Any equivalent national standard of another Member State of the European Union shall apply, if no equivalent national standard is available, then particular requirements related to specific materials will be set out elsewhere in this specification.

Any reference in this specification to an ISEN standard shall be taken to include the Irish National Annex. Any reference in this specification to a national standard shall be taken to mean the equivalent ISEN standard, if the national standard has been subsequently replaced by an ISEN standard, or if the co-existence period has elapsed.

1.3 REFERENCES TO STANDARDS/REGULATIONS/LEGISLATIVE ENACTMENTS/CODES OF PRACTICE

Where reference is made to Standards/Regulations/Legislative Enactments/Codes of Practice, the reference shall be deemed to apply to the issue, with amendments and addenda if any, current at the date of invitation to tender for the work.

1.4 TESTING OF MATERIALS

Particular attention of the Contractor is drawn to the requirement that all materials used (whether imported or re-used from materials recovered on the site) shall be tested and be accompanied by a certificate to be presented prior to their first use on the site, to demonstrate compliance with the recognized standards, including current Building Regulations (including Technical Guidance Documents recommendations) and other statutory requirements, NRA requirements, and other recognized construction industry body requirements.

Every item of material shall from time to time be subject to such tests as the Employer's Representative may prescribe and the materials tested shall conform in every detail with the requirements of the appropriate standard specification or with any other standard test which the Employer's Representative may lay down in the course of this Specification.

1.5 CERTIFICATION MARK

Wherever, in respect of any Irish Standard (either ISEN or IS), an NSAI Scheme of Supervision and Control is available, all materials required to comply with that Standard, or the containers of such materials, shall be marked with the Certification Trade Mark. This requirement shall not apply where the Employer's Representative is satisfied and confirms to the Contractor in writing that such materials are not readily available. In such a case or where an NSAI Quality Assurance Scheme is not available, but the materials are manufactured to the appropriate standard specification as certified by the appropriate certification body in the member state in which the product originates, the Contractor shall on request produce a certificate from the manufacturer stating that from each consignment a representative sample has been tested, and has proved to be in accordance with all the requirements of the said specification.

Notwithstanding the furnishing of this certificate, nothing shall prejudice or override the inalienable right of the Employer's Representative to have independent tests carried out. For the purpose of carrying out such tests the Employer's Representative shall have full authority to have the samples taken, either at the

manufacturer's factory or from consignments at the Works, and to submit the same to an approved Engineering Laboratory chosen by him for testing. Furthermore, the Employer's Representative shall have the right to reject any material as a result of such tests, notwithstanding that the manufacturer's certificates may have shown the materials to be satisfactory.

2 Site Clearance, Excavation & Earthworks

2.1 Site Clearance

The Contractor shall clear from the proposed locations of new structures and pipelines all trees, stumps, bushes, hedges, structures, and loose objects. Stumps of trees and roots shall be grubbed up or destroyed. Mature trees shall not be damaged or removed unless specifically required by the contract or instructed by the Employer's Representative.

All materials from the clearance shall be disposed of to a place approved by the Employer's Representative and acceptable to the Planning Authority. If required by waste management legislation, the appropriate disposal permit shall be obtained by the Contractor.

Existing buildings and/or structures specified for demolition elsewhere in this Specification shall be carefully demolished and rubble disposed of to a place approved by the Employer's Representative and acceptable to the Planning Authority.

2.2 Classification Of Excavation

Excavation for the purpose of this Specification and of the accompanying Pricing document and of the Contract shall be classified as (a) excavation in any material except solid rock, and (b) excavation in solid rock.

2.3 Methods Of Excavation

The Contractor shall carry out his excavating operations in such a manner as to avoid damage to or deterioration of the Final Surfaces. The Contractor shall be responsible for the safe preservation of existing underground services, and if any damage is occasioned thereto, the Contractor shall at his own expense make good all such underground services to the satisfaction of the Employer's Representative, and of the Authority concerned.

All excavations shall be to the widths, depths and lengths shown on the Drawings or described in the specifications, or to such alternative depths and dimensions as may be directed by the Employer's Representative.

The surfaces of road excavations shall all have saw cut edges.

Field turf shall be carefully cut into narrow widths and carefully rolled and stacked for later re-use. All productive topsoil shall be carefully stripped and stockpiled separately from other excavated material for subsequent re-use. It shall be kept free of weeds. The Contractor shall not cut or break down any live fences or trees in the line of the pipes without the permission of the Employer's Representative.

The Contractor shall examine the bottom of all excavations and shall call the attention of the Employer's Representative Site Staff to any unsound or weak places, which shall be dealt with in any such manner as the Employer's Representative may direct, and shall not commence any of the Permanent Works until the foundations have been approved by the Employer's Representative. If the bottom is damaged as a result of excavations or allowed to deteriorate the Employer's Representative shall be promptly informed. The Contractor shall in all cases carry out his operations in such a manner as to avoid such damage or deterioration of the final surface.

If any ground is excavated to a depth exceeding that shown on the Drawings or described in the Specification or otherwise than is necessary for the Works or to accord with the instruction of the Employer's Representative, such extra depth shall be made good with concrete or in such other manner as the Employer's Representative may direct.

The last 100mm above formation level shall not be excavated until immediately before concrete or other formation material is to be placed upon it.

The excavation bottoms are to be carefully examined for the presence of hard objects such as stones, rock projections or tree roots, and these removed and the bottoms then prepared. Filling the bottom of excavations or trenches to the level of any hard objects found on the bed is forbidden.

Excavations in and adjacent to roads and footways shall be adequately protected by substantial barriers and illuminated at night with lamps.

The Contractor shall remove and dispose of surplus and other excavated material and rubbish off the site at places to be located by himself which have a permit from the Local Authority or licence from the EPA. Such disposal shall take place at frequent intervals to prevent any accumulation of spoil and rubbish.

The sides of excavations shall be adequately supported at all times and, except where required by or permitted under the Contract, shall not be battered. No excavations with battered sides will be permitted within 30 metres of any building or other structure. In the event of any trench for pipelines being excavated with battered or stepped sides that portion of the trench which extends from the formation to a point not less than 300mm above the crown of the pipe shall be formed with vertical sides the minimum practicable distance apart but nowhere a greater distance apart than the maximum trench width indicated in this specification.

No excavated material suitable for re-use in the Works shall be removed from the Site except on the direction, or with the permission of the Employer's Representative.

Excavation for trenches up to 4.50 metres in depth shall be made in open cutting unless the Employer's Representative otherwise instructs or permits.

Excavated material to be used for backfilling shall be kept well clear of open trenches at least 1000mm from the edge of the trench and shall not be placed or stored in a manner which might constitute an excessive load on the open trenches or otherwise endanger the stability of the excavations or which causes obstruction to any road or right of way, or which jeopardises the safety of any person in or about the Works. If excavated material is deemed by the Employer's Representative to be unsuitable for refilling, then following disposal of same approved fill shall be imported to the site for this purpose. Where excavation is in Solid Rock the Employer's Representative's approval must first be obtained before excavated rock can be used as a backfilling material. In such cases crushing and screening may well be required before re-use and the Contractor shall be deemed to have included for this in his overall pricing.

Where a step occurs in the underside of a structure, the subgrade material at the step in formation level shall be excavated to its natural slope. The void formed by this additional excavation shall be backfilled with lean mix concrete to the underside of the structure.

Excavated material shall not be stacked along the sides of trenches. Unless otherwise permitted or directed by the Employer's Representative, excavated material shall be taken off site and temporarily stored for re-use in a location, approved by the Employer's Representative and the Local Authority and for which the Contractor has obtained Planning Permission if required. Where the excavated material is considered suitable for re-use by the Employer's Representative, the Contractor shall include for bringing the excavated material back for backfilling of trenches. Where the excavated material is unsuitable for re-use, it shall be removed to a permitted place of disposal approved by the Employer's Representative and the Local Authority and backfilling shall be carried out with imported fill consisting of Clause 804 material or as specified. The cost of this work shall be deemed to have been included in the Contractor's Rates and Prices as shall be the costs arising from obtaining the necessary Planning Permissions associated with the storage and/or disposal of excavated materials.

2.4 Dealing With Water

The Contractor shall not allow water to lie in any part of the Works unless required to do so under the Contract. Water arising from or draining into the Works shall be drained or pumped to an approved disposal point. Any drainage sumps required, shall where practicable, be sited outside the area excavated for the Permanent Works, and shall be re-filled with blinding concrete to the level of the underside of the adjacent Permanent Works.

The Contractor shall be liable for and shall make good any damage caused by prolonged or excessive pumping and shall take all necessary precautions to prevent any adjacent ground from being adversely

affected by loss of fines through any de-watering process. He shall also be liable for the safety of any adjoining structures, roads, buildings etc., by shoring or otherwise during the time that the excavations are open.

The Contractor shall take all necessary precautions to prevent any ground water from entering mains to be used for the conveyance of potable water.

2.5 Solid Rock

Rock shall mean natural rock formation which can properly be removed only by means of blasting, barring, or wedging or by some other recognised methods of quarrying. It shall also include solid rock boulders of one quarter cubic metre or more in volume which can only be removed by one or other of the aforesaid methods, existing concrete, or bonded masonry laid in mortar, but shall not include shale formations, tree trunks or such like objects, despite their removal by methods similar to those normally adopted in solid rock excavation.

Where rock or boulders are encountered in trenches the bottom of the trench shall be excavated to the additional depth specified before bedding is placed. No projection of rock closer than 200mm to the side of a pipe in trench shall be permitted. The trench width for the purpose of measurement of rock in trenches shall be deemed to be the maximum trench width defined in Section 8 – Pipelines.

2.6 Slips, Falls And Excess Excavation

Every precaution shall be taken by the Contractor to prevent slips and falls of earth and other material in the excavations. In the event of slips or falls occurring or in the event of excavation being made in excess of the minimum necessary or practicable for the construction of the Works the voids so formed shall be filled at the Contractor's expense. In all cases where the voids so formed may in the opinion of the Employer's Representative affect the stability of the ground for the support of the permanent works or of adjacent structures and services then such voids shall be filled solid with concrete Grade C12/15. In all other cases the voids shall be packed either with imported granular material or selected suitable excavated material thoroughly compacted.

2.7 Excavation In Narrow Passages

In narrow passages the excavated material shall be removed at once so as not to obstruct the passage, and shall be brought back when required for re-filling the trench or tunnel. The Contractor shall also include for excavation by hand where necessary in confined locations.

2.8 Backfilling – General

Backfilling shall, wherever practicable, be undertaken immediately the specified operations (laying, jointing, testing, haunching and surrounding watermain, sewers and other pipelines and final approval of the work as being in compliance with the appropriate sections of the Specification) preceding it, have been completed. Backfilling shall not, however, be commenced until the works to be covered have achieved a strength sufficient to withstand all loading imposed thereon.

Backfilling around tanks and other structures shall be undertaken in such a manner as to avoid uneven loading and damage, where appropriate, as the permanent work is built.

Filling material to excavations shall be placed in layers not exceeding 250mm unconsolidated thickness and compacted to form a stable backfill. Where the excavations have been supported and the supports are to be removed, these where practicable, shall be withdrawn progressively as backfilling proceeds in such a manner as to minimise the danger of collapse, and all voids formed behind the supports shall be carefully filled and compacted.

As filling proceeds, the greatest care shall be exercised in ensuring that the filling is sufficiently solid to take the thrust at the sides of excavations as timbering is removed. Vertical timbering shall be gradually

withdrawn and the top frames shall be retained until the whole of the filling in material is known to have thoroughly set.

2.9 Watching And Lighting

The Contractor shall fence, light and otherwise protect all open trenches and all heaps of accumulated material whether it has been excavated from the trenches or not. For night time warning to drivers adequate warning lights shall be placed to indicate all obstructions in the highway. The Contractor shall meet the requirement of the Code of Practice for Traffic Management (Section Four) in planning his Lighting System.

The Contractor shall be held responsible for accidents and damage arising from failure on his part properly to fence, guard and light as aforesaid and for the inconvenience or damage caused to the public or to property owners through his negligence in these matters.

2.10 Warning Signs

The Contractor shall wherever necessary erect warning signs of size and colour and with lettering to the approval of the Road Authority indicating that there is a constructional hazard "including a warning, where necessary, of restricted sight distances". He shall erect appropriate signs for the benefit of construction traffic to alert of dangers and for the benefit of the public road users to alert them of the danger of emerging construction traffic from the site. Such signs shall be arranged with the Employer's Representative Site Staff and the Employer's Personnel shall be consulted as to the location of signs, which may only be erected with his permission first obtained. All such signs shall be properly maintained while in use and shall be removed when need for them is no longer apparent.

Adequate warning to drivers approaching the excavation or road obstruction shall be provided with warning boards which meet the requirement of the Code of Practice on Traffic Management (Section Four). Such warning boards shall be maintained in a clean and easily legible condition and shall be moved daily or as required as the work proceeds so as always to be properly positioned for the convenience of road users.

Notwithstanding compliance with statutory public notices in the Press etc. where Roads are closed, the Contractor must provide Diversion Notices complying with the above Guidelines at all such locations as may be necessary so that no user of the road is obliged to retrace his steps upon discovery of the Works and the obstruction to passage.

2.11 Damage To Roads And Streets

If through the improper use of excavating machinery or through carelessness or for any other avoidable reason the Contractor excavates trenches to greater widths than are specified, or if in the remaining portions of roadways, pavement or footpath, damage is done to surfaces by caterpillar tracks or wheels of heavy machinery, the Contractor shall be entirely responsible for the complete restoration of the surfaces so damaged and shall himself restore them to the condition in which they were before the Contractor commenced his operations, or shall pay to the Employer the certified costs of such repairs.

2.12 Articles Of Value

All fossils, coins or articles of value or antiquity uncovered by the Contractor's excavations in any part of the Works shall be deemed to be the absolute property of the Employer, and the Contractor shall take reasonable precautions to prevent his workmen from removing or damaging any such articles or things and shall immediately upon discovery and before removal acquaint the Employer's Representative of such discovery and carry out the Employer's Representative's orders as to the disposal of the material.

2.13 Interference With Underground Services

The Contractor shall comply with the "Code of Practice for Avoiding Danger from Underground Services" published by the Health and Safety Authority in February 2005.

Before the commencement of work in any area where there is likelihood of interference with Underground Services of any kind, the Contractor must first of all consult with all the Service Authorities and obtain from them site location information.

Where locations of existing services are identified following consultation with the Service Providers the Contractor shall if necessary, carry out trial excavations or other investigations so that all available information regarding the service may be obtained before excavating in the vicinity of same. Where an unanticipated service is encountered in excavation the Contractor shall immediately call the attention of the Employer's Representative Site Staff and the appropriate Authority thereto.

A proper record shall be kept to show the precise position of services encountered. Location seeking of the various services can only be carried out under the supervision of the particular Authority concerned with that service.

The Contractor shall make all arrangements for the temporary shoring up and supporting, diversion when permitted by the owner, and keeping in operation all sewers, drains, land drains, gas, water and other pipes, culverts, electricity, broadband and telephone cables, etc., as may be affected, disturbed or exposed by his operations. In the event of any damage during or after the execution of the Works, he shall immediately notify the Authority or owner concerned and shall be liable for the full cost of such remedial works as may be determined by that Authority or owner and including consequential damage to the property of third parties which may arise from the execution of the Works.

Where permanent diversion or permanent support is rendered necessary as the unavoidable result of the construction of the Works in accordance with the Contract or where in the opinion of the Employer's Representative Site Staff the position of existing services over 75mm external diameter which cross the permanent work for a distance not less than five times the net width thereof warrants temporary diversion or support the Employer's Representative Site Staff will instruct the Contractor accordingly.

Before commencing any work which may affect the flow in any sewer or storm drain the Contractor shall submit, and obtain the approval of the Employer's Representative to his detailed proposals for maintaining or temporarily diverting the flow. Standby pumping equipment with day and night attendance shall be provided where the Contractor proposes to pump the flow and in general, he shall provide and fix all necessary dams, chutes, tanks and other plant and labour as may be required.

Temporary pumping for diversions or overpumping of existing sewers shall be arranged with electrically operated pumps from ESB mains supply as the continuous 24 hour running of diesel pumps or generators adjacent to residential properties will not be permitted.

The Employer's Representative will not approve any proposal for the temporary diversion of flow, which does not provide capacity equal to or greater than that which it replaces or which unnecessarily affects the sewer conditions upstream. Notwithstanding that such works may be required only for a limited period they shall if so required by the Employer's Representative be constructed to a standard similar to that specified for the permanent works.

Any temporary works constructed for the diversion of flow shall be entirely removed and the connections to the existing structures made good if and when the Employer's Representative shall so order. Where the Employer's Representative considers that the removal of the temporary works would involve risk to the permanent works or other structures or would give rise to undesirable further opening up of ground surfaces he may direct the Contractor that such temporary works are to be cleaned out and filled in as specified.

2.14 Disposal Of Surplus Excavated Material

The Contractor shall provide for the disposal of all surplus excavated material not required for use in or on the Works. The place of disposal shall be a licensed tip site and must be approved by the Employer's Representative and the Planning Authority concerned. Transport of surplus excavated material shall be carried out by a licensed haulier. Disposal of all surplus excavated material shall be carried out in compliance with the requirements of the latest Waste Management Regulations, and more specifically disposal of excavated material shall comply with the provisions of the Waste Management (Facility Permit and Registration) Regulations, SI 821 of 2007.

As each trench is refilled the surplus earth shall be properly removed, and in no circumstances will the Contractor be allowed to leave spoil heaps or loose and uncollected rubbish along trench lines or on any site.

At completion all surfaces shall be properly restored and roadways, pavements, paths, yards, gardens, fields and any other place disturbed during the execution of the work shall be left as they were found, neat and tidy and free from accumulation of excavated soil.

2.15 Obstruction Of Roads

The Contractor shall not occupy or obstruct by his operation more than one half of the width of any road or street.

If it becomes necessary with the approval of the Local Authority first obtained to restrict traffic to a single lane, properly trained and alert flagmen shall be provided to direct traffic. One-way traffic will not be permitted over continuous lengths of road exceeding 100 metres except in very exceptional circumstances or where the density of traffic is light.

2.16 Closing Of Roads And Temporary Bridges

In streets or along roads where traffic may conveniently be diverted the Contractor may make written application for permission to close a road. Before any road can be closed to vehicular traffic the Contractor must be obtained the written consent of the Employer's Representative and the Employer, and must ensure that all statutory obligations preliminary to the closing of the road have been complied with. Even if a road is closed to vehicular traffic a footway for pedestrian traffic must be kept clear.

In addition to the obligation imposed upon the Contractor under the provisions of other Clauses to provide temporary footways and bridges in locations where private holdings are divided into two parcels by the pipeline trench, the Contractor will also be obliged to provide a similar convenience for the public while trenches are open in all roads, either Public or Private. Such temporary bridges shall be built solid with 225mm x 75mm planks tightly cramped together with a minimum width of 1600mm or alternatively sheet steel properly supported may be used. Guardrails 900mm over the deck of the temporary bridges shall be provided and toe boards shall be fixed 225mm high on each side of the footway. Entries to footways shall be kept clean and spoil heaps shall be kept back so that accident or injury to pedestrians will be obviated.

2.17 Material Excavated From Public Property

Earth, stone, gravel, clay, turf, sand, timber and all other materials and things excavated from works on public property shall not become the property of the Contractor. Permission may, however, be given to the Contractor to use the same for the purposes of the Contract, provided no detriment to the works is occasioned thereby and that such portion of the said materials as the Contractor is permitted to re-use are suitable and in accordance with the terms of the Specification.

2.18 Material Excavated From Private Property

Surplus earth, stone, gravel, clay, sand or other material excavated from any trench on private property shall become and be deemed to be the property of the owner of the lands and shall, if the owner of the lands asserts his ownership, be dealt with by the Contractor according to his instructions, except that the Contractor will not be required to remove any materials for such land owners to a greater distance than 500 metres from the trench.

If on the other hand the owner of the property does not require the material then the Contractor shall remove and dispose of it in accordance with the appropriate clause hereof.

2.19 Removal Of Offensive Material

All offensive material met with during the progress of the works shall not be deposited on the surface of any street or placed near dwelling houses where it is likely to cause a nuisance, but shall be forthwith placed in bins and thereupon, without delay removed to a suitable place of disposal provided by the contractor and approved by the Employer's Representative and the Local Authority.

The Contractor shall take great care and all reasonable precautions to ensure that roads and thoroughfares used by him either for the construction of the works or for the transport of plant, labour and materials are not dirtied as a result of such construction or transport and in the event of their becoming thus dirtied in the opinion of the Employer's Representative Site Staff the Contractor shall take all necessary and immediate steps to clean them.

2.20 Protection Of Trenches

The Contractor shall ensure that the trenches are safe for passing traffic, pedestrians and children. The Contractor shall erect warning signs at suitable intervals on either side of such excavations, he shall erect a protective barrier around excavations together with luminous tape and he shall provide warning lights. Where excavations are close to paths, the Contractor shall erect an orange coloured PVC mesh fence, 1 metre high along the kerb line as a further barrier for the protection of pedestrians. The path and any road open to pedestrians within the working area or affected by construction traffic shall be swept regularly to keep the area free of small stones, loose gravel or debris arising from the contract work. In trenches and other excavations where there is a build up of water, the Contractor shall arrange to have continuous pumping or alternatively he shall arrange to fence off such trenches or excavations.

The Contractor shall nominate a person with responsibility for warning signs, lighting and protective barriers at open excavations who shall check these items at regular intervals outside normal working hours.

The Contractor will be required to erect protective barriers or hoardings along the sides of trenches to screen the working area from the public and such barriers or hoardings should be of sufficient height to prevent the arm of an excavating machine from inadvertently slewing out over trafficked areas. These hoardings shall be provided in locations as instructed by the Employer's Representative and they shall be required generally in trafficked areas and in narrow streets.

2.21 Damage To Boundary Walling

The Contractor shall be responsible for the restoration and making good of all boundary walling indirectly damaged or affected by the use of explosives or machinery during the course of construction.

3 Non Structural Building Works

3.1 Vapour Resisting & Water Proofing Membranes

3.1.1 Radon Barriers

All radon barriers shall at a minimum comply with the requirements of the Building Regulations and in particular shall be as per Technical Guidance Document C and any material or product used shall have the relevant Agrément certification or equivalent. All Radon membrane should be installed strictly in accordance with the manufacturers requirements and as indicated on the relevant certificate.

All radon barriers shall be laid on blinding on the hardcore to reduce the risk of damaging the membrane during placement.

Final approval should be sought from the Employer's Representative on the type of membrane prior to installation and particular care should be taken where penetration through the membrane occurs and proprietary products should be used to seal around any penetrations.

Detailed guidance on radon is obtained in the Department of the Environment publication "Radon for Buildings".

3.1.2 Radon Sumps and Pipe Work

Where an underground radon sump is required as noted on relevant drawings, the sump shall consist of a proprietary radon collection box and comply with the requirements of the Building Regulations and in particular shall be as per Technical Guidance Document C and any material or product used shall have the relevant Agrément certification or equivalent.

A 100mm diameter pvc pipe or equivalent should be inserted to the sump and extended horizontally to the outside of the building and turned up and capped with proprietary radon pipe cap for the future connection to extracting fan cowl should this be required at a later date by the client.

3.1.3 Damp Proof Membranes

All damp proof membranes (DPM) shall at a minimum comply with the requirements of the Building Regulations and in particular shall be as per Technical Guidance Document C and any material or product used shall have the relevant Agrément certification or equivalent.

Final approval should be sought from the Employers Representative on the type of membrane prior to installation and particular care should be taken where penetration through the membrane occurs and proprietary products should be used to seal around any penetrations.

All damp proof membranes should be a minimum of 1200-gauge material with minimum 150mm overlap at joints on blinding to reduce the risk of damage to membranes.

3.1.4 PVC Water Stop Strips

All PVC waterstop systems shall at a minimum comply with the requirements of BS 2571 – “Specification for general-purpose flexible PVC compounds for moulding and extrusion” and BS 903 – “Physical testing of rubber. Guide of practice for protection of structures against water from the ground”. Any material or product used shall have the relevant Agrément certification or equivalent. PVC water stops should have a minimum tensile strength of 15.0 N/mm².

Waterstops may be cast centrally in the concrete to resist internal and external water pressure or may also be cast on the external face for water retaining structures. A fully continuous waterstop network must be formed using factory made junction and intersections with site jointing limited to simple welds of similar section to the strip profile.

All water stops should be placed and secured in position by trained personnel in accordance with the manufacturers details and specification.

Water stops should not be left exposed for more than 7 days before concrete encapsulation.

Final approval should be sought from the Employer’s Representative on the type of waterstop prior to installation and a certificate or guarantee will be sought on completion of the works.

3.2 Floor Construction

3.2.1 General Requirements

All structural elements of floor construction are to be in accordance with the Structural Engineers details and shall comply with all relevant codes and standards as appropriate at the time of construction.

All unbound granular fill materials to be used under floors, rafts, foundations or other structures in the ground, roads, footpaths or other pavements, shall conform with the requirements of IS EN 13242 and Table E.1 from Annex E of SR21, in addition to any other requirements specified in other sections of this specification. Similarly, all aggregate for use in concrete, for whatever purpose, shall at least comply with these requirements, in addition to all other requirements in this specification.

Only natural crushed rock aggregates shall be used under any concrete structure, including floors, rafts or other foundations, road pavements or footpaths.

Prior to first use from any source, the Contractor shall obtain from the supplier confirmation of the material having been tested from the specific source (including the particular extraction section of the quarry in accordance with the practice recommended in SR21), and provide certification as evidence of such testing confirming that the materials conform to the requirements set out above. The Contractor shall not supply any materials from any different source (or different extraction source from a quarry) unless appropriate testing in accordance with the above requirements has been carried out and certification provided.

For the avoidance of doubt, the above requirements in relation to fill material, shall apply to all fill material directly underneath any of the elements identified, and any fill materials within 500mm to any side of any such elements

3.2.2 Floor Tolerances

All floors are to be laid in accordance with BS 5606:2022 and BS 8204-1:2003 Guide to Accuracy in Buildings and Screeds, Bases and In Situ Flooring respectively. All finished floor surfaces are to be laid to a minimum flatness tolerance of +/- 5mm over a 3m straight edge as set out in Table 1 of BS 5606 unless stated otherwise. Particular care should be taken in areas that are to receive a floor finish i.e. tiles or carpet at a future date. All floors with gulley outlets to be laid to suitable fall for ease of drainage.

3.2.3 Concrete Floor Finishes

All concrete floor finishes are to be as follows unless stated otherwise:

Class U1:

This is a floated finish for surfaces of slabs to receive a tiled or similar finish or expose slabs where a hard smooth steel trowelled finish is not specified. Floating shall be done only after the concrete has hardened sufficiently and may be done by hand or machine. Care shall be taken that the concrete is worked no more than is necessary to produce a uniform surface free from screed marks.

Class U2:

This is a hard smooth steel trowelled finish for exposed surfaces of slabs where required by the Engineer. Trowelling shall not commence until the moisture film has disappeared and the concrete has hardened sufficiently to prevent excess laitance from being worked to the surface. The surface shall be trowelled under firm pressure by hand or by machine and shall be left free from trowel marks.

Except where Class U1 and Class U2 special finishes are specified, all concrete unformed surfaces shall be levelled and screeded to produce a uniform plain or ridged surface surplus concrete being struck off by a straight edge immediately after compaction. This shall also be the first stage for Class U1 and Class U2 special finishes.

3.3 Roof Construction

3.3.1 Roof Construction

All structural elements of roof construction are to be in accordance with the Structural Engineer's details and shall comply with all relevant codes and standards as appropriate at the time of design/construction. All roof construction is to be carried out in accordance with the relevant drawings.

The sound requirements for all roof structures shall meet with the requirements of the Building Regulations and in particular Technical Guidance Document E.

A 25 year materials and workmanship guarantee to be provided for the roof materials.

Allowance to be made to carry out roof electronic integrity tests on all areas of roofing.

3.3.2 Roof Drainage

All roof drainage details including, gutter size, downpipe size, and location of pipes shall be as per the relevant drawings.

The gutters and down pipes may be constructed using uPVC, aluminium, insulated pressed metal and all shall be supplied and installed in accordance with the manufacturer's instructions. All non-domestic downpipes are to have a 100mm diam. Equivalent cross sectional area. All internal gutters and downpipes to be insulated type unless noted otherwise.

Downpipes are to be concealed where possible. All downpipe locations to be approved by the Employer's Representative prior to installation.

Unplasticised PVC waste pipes, shall comply with BS 4514 and BS 3959 Class E. Fittings etc. shall comply with BS 4346 Part 1.

Jointing rings, couplings, adaptors and supports shall be of types recommended by manufacturer of pipes being jointed.

Where Syphonic drainage systems are used they shall be designed and installed by a specialist sub-contractor and full design calculations shall be reviewed and approved by the Employer's Representative prior to installation.

3.3.3 Damp Proof Course and Flashings

Damp proof course and Flashings to Masonry Walls all to be specific for the intended use and all shall have appropriate certification. Damp proof course to be provided minimum 150mm above ground level, over all opes and at jambs of cavity walls and generally as set out in the Building Regulations.

Lap 150mm at joints and the full width at angles and junctions. Damp proof course shall be laid at sides of opes in cavity walls and over all opes 250mm longer than the opes stepped down and outward to prevent passage of moisture from outer to inner leaf. DPC shall be laid under the turned up ends and back of all cills and external room ventilation grids. Where the waterproofing membrane in a concrete floor is not level with the DPC care shall be taken to ensure continuity of damp proofing by stepping, turning up and lapping as necessary. Construction of damp proof courses shall comply with the relevant provisions of CP102: Section 3 and BS 5628.

Stepped DPC in cavity walls to be provided above opes and above any roofs abutting the cavity walls.

All cills to be laid on DPV tray turned up at sides and ends.

DPC over lintels / opes to extend minimum 100mm beyond lintel ends. Provide weep holes at 450 centres in brickwork at base of stepped DPC.

All flashing to be minimum Code 5 lead.

4 Concrete And Formwork

4.1 General

Except where otherwise indicated in this Specification, the recommendations of BS 8110 – The Structural Use of concrete, BS 8007 – Design of Concrete Structures for Retaining Aqueous Liquids and IS EN 206-1 – Concrete Specification, Performance, Production and Conformity, shall apply. Ordinary structural concrete shall be used unless otherwise specified.

Ordinary structural concrete shall contain only the following:

CEM I, CEM II/A, CEM III type cements in accordance with IS EN 197-1, and in any combinations thereof as permitted in IS EN 206-1.

Aggregates comprising Natural Sands or Gravels or Crushed Stone as specified and complying with Clause 4.2.1 of this Specification.

Water that is clean and free from harmful matter and complying with Clause 4.2.5 of this Specification.

4.2 Materials

4.2.1 Aggregates for Concrete and Unbound Granular Fill Materials

All unbound granular fill materials to be used under floors, rafts, foundations or other structures in the ground, roads, footpaths or other pavements, shall conform with the requirements of IS EN 13242 and Table E.1 from Annex E of SR21, in addition to any other requirements specified in other sections of this

specification. Similarly, all aggregate for use in concrete, for whatever purpose, including for use in concrete blocks, shall at least comply with these requirements, in addition to all other requirements in this specification.

Only natural crushed rock aggregates shall be used under any concrete structure, including floors, rafts or other foundations, road pavements or footpaths.

Prior to first use from any source, the Contractor shall obtain from the supplier confirmation of the material having been tested from the specific source (including the particular extraction section of the quarry in accordance with the practice recommended in SR21), and provide certification as evidence of such testing confirming that the materials conform to the requirements set out above. The Contractor shall not supply any materials from any different source (or different extraction source from a quarry) unless appropriate testing in accordance with the above requirements has been carried out and certification provided.

For the avoidance of doubt, the above requirements in relation to fill material, shall apply to all fill material directly underneath any of the elements identified, and any fill materials within 500mm to any side of any such elements.

4.2.2 Portland Cement

Normal Portland Cement (NPC) and Rapid-Hardening Portland Cement (RHPC) used in concrete, concrete products and other cement based products shall be certified as complying in every respect with the current issue of IS EN 197-1 and 2.

Manufacturer's or Supplier's Certificate of Compliance with the standard shall be provided when requested by the Employer's Representative, but the furnishing of these Certificates shall in no way prejudice or override the rights of the Employer's Representative to have independent tests carried out.

The Contractor shall obtain, with the first delivery to the Site, a Manufacturer's Certificate in accordance with IS EN 197-1.

Cement in transit shall be protected from the weather and shall be stored at the Works in weatherproof buildings and, if delivered in bags, on dry floors raised above ground level. If different brands of cement are in use, a separate store shall be used for each brand.

4.2.3 Cement Additions

IS EN 206-1 permits Ground Granulated Blastfurnace Slag (GGBS) to be used as a Type II in addition to Normal Portland Cement in concrete. Where GGBS is added, it replaces Portland cement on a one-for-one basis. The total cementitious material content of the concrete mix does not change, and the GGBS counts fully towards the total cement content and water/cement ratio in concrete. GGBS shall comply with BS 6699: Specification for Ground Granulated Blastfurnace Slag for use with Portland cement.

Written approval of the permanent works structural designer shall be obtained prior to using a cement combination comprising GGBS.

4.2.4 Admixtures

Admixtures shall not be used without prior written approval of the permanent works structural designer. The use of admixtures containing calcium chloride is prohibited. The permanent works structural designer may request comparative trial mixes, with and without a proposed admixture, to determine the effects of the admixture on concrete properties. The cost of these trial mixes shall be borne by the Contractor.

Air-entraining, accelerating, retarding, water-reducing and superplasticising admixtures for concrete grout or mortar shall comply with the relevant provisions in IS EN 934.

Admixtures containing chlorides shall not be used in reinforced concrete designed to retain aqueous liquids.

4.2.5 Water

Water for use in concrete shall comply with IS EN 1008 Mixing Water for Concrete. It shall be clean, free from turbidity and suspended matter. It shall also be free from ice or snow at the time of use.

4.2.6 Aggregates

4.2.6.1 General

Aggregates for concrete, including concrete blocks, shall be obtained from an approved source and shall conform to the requirements of IS EN 12620 'Aggregates for Concrete', and shall conform with the requirements of IS EN 13242 and Table E.1 from Annex E of SR21, in addition to any other requirements specified in other sections of this specification. Fine aggregate for mortar shall be washed natural sand or crushed natural stone and shall comply in all respects with IS EN 13139 'Aggregates for Mortar' and PD 6682-3. Lightweight aggregate for concrete, mortar and grout shall comply with IS EN 13055-1.

All-in aggregate shall not be used for the production of structural concrete. Recycled aggregate and recycled concrete aggregate shall not be used in contact with raw or potable water. The coarse aggregate shall be stored separately in its nominal single sizes until final batching immediately prior to production of concrete.

The Contractor shall submit to the Employer's Representative full details of his proposed aggregate source including the following:

- (a) Location and supplier's production facilities.
- (b) Petrology and possible variability.
- (c) Proposed aggregates, processed sizes and results of at least three sieve analyses.
- (d) Certification from the Supplier that the output from the source of production consistently conforms to the requirements of the appropriate specifications of IS EN 12620.
- (e) Details of typical physical and chemical properties of aggregates from the source, as listed in IS EN 12620.
- (f) Samples of each size of aggregate taken in accordance with IS EN 12620.

All quarries or other sources of materials shall be required to provide a detailed mineralogical report prepared by a suitably qualified and experienced petrographer attesting to the material's suitability for use in the works.

Aggregates shall consist of natural sands and gravels, crushed stone, or other suitable material. They shall be clean, hard, strong, sound and durable, and shall be free from clay, silt, loam and other organic matter, shells, mica, shale, coal, slag, soluble sulphates, adherent coatings, and all other extraneous deleterious matter, liable to reduce the strength or durability of the concrete, or to attack the steel reinforcement. The total Sulphur Content of aggregates should not exceed 1% (Category SI).

The Contractor shall produce, with the first consignment of each size of aggregate, a sieve analysis carried out on a sample of the consignment. If any such or other sample does not conform with the Specification, the aggregate it represents shall be promptly removed from the Site and the Contractor shall carry out such modifications to the storage arrangements as may be necessary to secure compliance with the Specification.

Any changes in the particulars of the aggregates, which occur during the course of the Contract, must be notified to the Employer's Representative without delay.

4.2.6.2 Fine Aggregates

Fine Aggregate with a sharp natural pit sand or fresh water sand and it shall be washed either at the quarry or at the Works if the Employer's Representative requires. It shall mainly pass a 5mm test sieve, and

it shall contain only so much coarse material as may be permitted for the various classes of concrete which are specified.

4.2.6.3 Coarse Aggregates

The term "Coarse Aggregate" shall mean an aggregate mainly retained on a 5mm IS test sieve, and containing only so much fine material as may be permitted for the various classes of concrete specified. The term 'all in aggregate' shall mean aggregate containing a proportion of materials of all sizes as obtained from pit, riverbed, quarry, or crushing plant.

4.2.6.4 Storage

The aggregates shall be stored on Site in separate stockpiles and arranged as to prevent the intermingling of the various aggregates. The stockpiles shall be suitably protected to prevent contamination of the aggregates from the ground, rubbish, or by leaves, dust or other wind blown material. Adequate drainage facilities shall be provided for each stockpile and aggregate shall not be used which contains ice or frozen material. Aggregate shall be stored in sufficient quantity to ensure continuity of supply for the duration of the Contract.

4.2.6.5 Testing

Periodic sampling and testing of aggregates, to show compliance with all of the requirements of this Specification, during the progress of the Works shall be carried out in accordance with the requirements of IS EN 12620, IS EN 13242 and Table E.1 from Annex E of SR21, and for this purpose the Contractor shall deliver the appropriate quantities of the different aggregate sizes free of charge upon the contract at a nominated Engineering Laboratory, which in general shall be that attached to the Engineering School of the Constituent College of the National University of Ireland or any other approved Engineering Laboratory which is most convenient to the place at which the Works are in progress. The cost of testing shall be borne as follows:

By the Employers as a charge against the appropriate item in the Bill of Quantities in the event that the material complies with the terms of IS EN 12620:2002 and as such is approved by the Director of the Testing Laboratory or

By the Contractor in the event that the material does not comply with the terms of IS EN 12620:2002 and is in consequence rejected by the Director of the Testing Laboratory.

4.2.7 Sands

Sands for mortar and grout shall comply with IS EN 13139 and PD 6682-3.

Sands for floor screeds shall comply with the relevant provisions of IS EN 12620 and PD 6682-1.

Sands for external rendering and internal plastering with lime and Portland cement shall comply with the relevant provisions of IS EN 13139 and PD 6682-3.

All sands complying with IS EN 12620 and PD 6682-1, IS EN 13139 and PD 6682-3 shall be washed sands.

4.2.8 Shuttering

Rough-finish shuttering shall consist of boards, sawn from good sound timber free from defects, sheet metal or any other suitable material, which will prevent the loss of grout when the concrete is vibrated.

Fair-finish formwork shall be faced with wrought or thickened boards with square edges arranged in a uniform pattern. Plywood or metal panels may be used provided they are free from defects likely to detract from the general appearance of the finished surface and provided the plywood is resin bonded.

Joints between boards and panels shall be horizontal and vertical unless otherwise directed.

4.2.9 Steel Reinforcement

Steel for reinforcement shall comply with the following British Standards as appropriate.

BS 4449	Steel for Reinforcement of Concrete: Weldable Reinforcing Steel: Bar Coil and Decoiled Products
BS 4482	Steel Wire for the Reinforcement of Concrete Products
BS 4483	Steel Fabric for the Reinforcement of Concrete

All reinforcing steel delivered to site shall be accompanied by Certificates showing compliance with the above Standards. All reinforcing steel shall be from an approved supplier certified by the UK Certification Authority for Reinforcing Steels (CARES) or a similar equally approved independent Certification Body.

Epoxy coated steel and reinforcing bars shall conform to the relevant provisions of BS ISO 14654 and BS ISO 14656.

Steel fabric reinforcement shall be welded at the intersections and unless otherwise required by the Contract, shall be delivered to the Site in flat sheets.

4.2.10 Tying Wire

Tying wire for steel reinforcement shall be 1.6mm diameter finally annealed mild steel wire, complying with BS 6744.

4.2.11 Cover Blocks and Spacers for Reinforcement

Cover blocks and spacers shall be designed, in accordance with BS 7973: Part 1 and 2, to maintain the correct clear cover of concrete over steel reinforcement, shall be as small as possible consistent with their purpose, and of a shape acceptable to the Employer.

Concrete cover blocks shall be manufactured with a 10mm maximum aggregate size and otherwise produced to the same specification as the surrounding concrete.

Spacers shall be of rust-proof material and shall not produce staining, or otherwise be detrimental to the concrete or steel.

4.2.12 Sealants for Joints in Concrete

Joint sealing compounds shall be impermeable ductile materials of a type suitable for the conditions of exposure in which they are to be placed and capable of providing a durable, flexible and watertight seal by adhesion to the concrete throughout the range of joint movement.

In sewage/wastewater retaining structures, only microbiologically resistant sealants, certified as suitable for contact with sewage, shall be used.

In water retaining structures in water treatment works and in structures containing potable water, only sealants, certified by WRC (Water Research Council) as suitable in contact with potable water, shall be used.

Hot applied sealing compounds shall comply with BS 2499, Ordinary Type A1 sealant. Polysulphide type sealing compounds shall comply with BS 4254.

Cold poured polymer-based sealants shall comply with BS 5212: Part 1, Normal Type N sealant.

Primers for use with joint sealants shall be compatible with and obtained from the same manufacturers as the adjacent sealant. Primers shall have no harmful effects on concrete.

4.3 Compressive Strength Classes Of Concrete

The compressive strength class of concrete to be used in the Works shall be as directed in Specification Volume A1 and on the relevant drawings. For each compressive strength class of concrete the minimum

works cube strength and minimum cement content per cubic metre of concrete shall be as set out as follows:

Compressive Strength Class	Max Size of Aggregate	Min Characteristic Cylinder Strength (N/mm ²)	Min Works Cube Strengths (N/mm ²)	Min Characteristic Cube Strength (N/mm ²)	Min Cement Content (kg/m ³)
		28 Day	7 Day	28 Day	
C40/50	20mm	40	42.5	50	325
C35/45	20mm	35	38	45	325
C30/37	20mm	30	32	37	325
C28/35	20mm	28	30	35	300
C25/30	10mm	25	25.5	30	340
C20/25	20mm	20	21.3	25	290
C16/20	20mm	16	17.0	20	250
C12/15	20mm	12	12.7	15	180

Table 4.1: Compressive Strength Classes of Concrete

4.4 Exposure Classes

The minimum compressive strength class of concrete, cement content and water content ratio to be used in various sections of construction should be as outlined in Clause 4.3 above or as per IS EN 206-1 based on the exposure classes outlined below, Whichever is greater.

Structural Element	Exposure Classification
Foundations (Subject to Long-Term Water Contact)	XC2
Marine Structures Permanently Submerged	XS2
Marine Structures in Tidal Zone	XS3
Water Retaining Structures	XC4
External Concrete Elements – Horizontal	XF3
External Concrete Elements – Vertical	XF1
Internal walls, beams, columns, slabs in building structures	XC1
Concrete in Chemically Aggressive Environment	X1, 2 or 3 as per IS EN 206-1:2000 Table 8.1

Table 8.2: Exposure Classes

Note: For a definition of the various Exposure Classifications see IS EN 206-1, Table 8.1 and Table 8.2. For details of maximum water/cement ratio minimum strength class and minimum cement content for each exposure class, see IS EN 206-1, Table F1.

4.5 Maximum Cement Content

Total Cement contents in excess of 400kg/m³ shall not be used.

4.6 Water Content

The water/cement ratio shall be the minimum value possible consistent with producing a concrete of the specified consistence and complying with the relevant requirements of the Specification. The water content shall be such that excess water does not appear on the top surface on completion of compaction of the concrete in the formwork. In the measurement of water content, due allowance shall be made for the water content of the aggregates. In water retaining structures the water/cement ratio shall be limited to a maximum of 0.55. In addition to this requirement, the water/cement ratio should be as per IS EN 206-1, Table F1.

No water shall be added to the concrete after it has left the Batching Plant.

4.7 Consistence

The consistence of concrete being placed shall be such that the concrete is suitable for the conditions of handling, placing and compaction, so that after compaction, all reinforcement is surrounded and the formwork is completely filled, without segregation or bleeding and to the required finish, with concrete complying with the relevant provisions of this Specification.

4.8 Alterations In Mix Proportions

Mix proportions shall not be altered without the prior approval of the permanent works structural designer. Such approval will be subject to compliance with the appropriate provisions of the Specification in relation to trial mixes, their sampling and testing.

4.9 Concrete Production

4.9.1 General

In addition to the following requirements, concrete production shall be subject to the requirements of IS EN 206-1.

The Contractor shall provide adequate supervision and control of concrete production at the works to ensure that materials and workmanship are to the required standard and consistency in order to produce concrete complying with all of the relevant requirements of the Specification. Only competent concrete operatives shall be used, supervised by a qualified foreman.

4.9.2 Batching

In addition to the following requirements, the batching process shall be subject to the requirements of IS EN 206-1.

All batching and mixing plant shall be maintained in clean, serviceable and accurate condition. The quantities of cement, fine aggregate and coarse aggregate shall be measured by weight. A separate weighing device shall be provided exclusive for weighing the cement. In the case of bagged cement, the cement may be measured by using a whole number of bags in each batch and by adjusting the batch quantities to maintain design proportions. The amount of water shall be measured by volume or by weight.

The accuracy of measuring equipment shall be such that the actual quantities of cement, fine aggregate and water in the cement mix shall be within plus/minus 3% of the design quantities. The water content of aggregates shall be continuously monitored and due allowance shall be made in the batching of the aggregate and water to ensure that the design quantities of dry aggregate and water are contained in the concrete mix. All batching equipment shall be used strictly in accordance with Manufacturer's Instructions.

4.9.3 Mixing

In addition to the following requirements, the mixing process shall be subject to the requirements of IS EN 206-1.

The concrete mixer shall comply with the requirements of BS 1305, tested in accordance with BS 3963. The concrete shall be mixed to a uniform consistency and colour. The minimum mixing time and maximum batch shall be in accordance with the manufacturer's instructions, unless otherwise directed.

Each concrete batch shall be completely discharged before recharging the mixer. Where the mixer has not been in use for more than 30 minutes, the mixer shall be thoroughly cleaned out before any fresh concrete is made.

The mixer shall be used strictly in accordance with the manufacturer's instructions.

4.10 Transport

In addition to the following requirements, the Transport of Concrete is also subject to the requirements of IS EN 206-1.

Concrete shall be transported from the mixer to its final position by means approved by the Employer's Representative. The transporting equipment shall be clean and free from contamination and accumulation of hardened concrete. Concrete shall be transported in such a manner as to avoid segregation, contamination and loss of ingredients and to ensure that the concrete is of the required workability at the point and time of placing.

4.11 Placement And Compaction

Concrete shall not be placed in any part of the structure until formwork, reinforcement, inserts and water bars, means of mixing, transporting, placing and compaction have all been inspected and approved by the Employer's Representative. Such approval shall be obtained 24 hours prior to concreting and sufficient time shall be allowed for the Employer to make such an inspection and order any alterations that should be made.

Unless otherwise approved by the Employer's Representative, concrete shall be discharged, placed and compacted in its final position, in one operation, under the direct supervision of a competent member of the Contractor's staff.

The concrete shall be placed in the positions and sequence indicated on the Drawings, in the Specification or as directed by the Employer's Representative. It shall be placed in such a manner as to avoid segregation of concrete, or displacement of formwork, reinforcement, inserts or water bars. Concrete shall not be allowed to fall freely more than 1.5m unless otherwise approved by the Employer. A suitable tremie pipe shall be used in all concrete pour lifts greater than 1.5m, to deposit the concrete as close as possible to its final location. Concrete placement and compaction shall proceed continuously between approved construction joints. Concrete which has partially hardened, has been adversely affected by delay or by weather, has become contaminated or segregated, or has fallen outside the section of formwork being filled shall not be used.

The depth of lifts and size of sections to be concreted shall be determined by the Contractor and shall be subject to approval by the Employer's Representative. In any case, pour sizes will be limited to a maximum of 15 metres in any direction. Pour depths will be limited to a maximum of 900mm in depth. Concrete shall be thoroughly compacted by vibration, or other means approved by the Employer's Representative, or thoroughly worked around reinforcement, inserts, water bars and corners of formwork to ensure a solid mass free of voids throughout and to achieve the required surface finish. Where vibrators are used for compaction, vibration shall be applied continuously during concrete placement and until the expulsion of air has practically ceased and in a manner which avoids segregation. All concrete shall be compacted to its final position within 30 minutes of discharge from the mixer, unless otherwise directed by the Employer. When in situ concrete has been in place for four hours, no further concrete shall be placed against it for a further twenty hours.

4.12 Depositing Concrete Under Water

No concrete shall be deposited under water unless the specific approval of the Employer's Representative has been obtained in writing that the work shall be so undertaken. The cement content of such concrete shall be increased by an amount not less than 25% of the minimum quantities previously specified for the respective grades of concrete. The greatest care shall be taken in depositing the concrete to prevent the separation of the ingredients, and an approved drop bucket or tremie pipe shall be used for this purpose. Concrete shall be deposited continuously once the operation has begun, and the top surface shall be kept as nearly level as possible until the required height has been reached. When concreting is finished, the work shall be carefully covered up and the water shall be prevented from disturbing the concrete until it has been completely hardened.

4.13 Ready-Mixed Concrete

The use of ready-mixed concrete shall be in accordance with IS 194, Method of Production and Supply of Ready-Mixed Concrete. The Contractor shall ensure that the concrete supplied by the Ready-Mixed

Company complies with all of the relevant provisions of the general specification. The Contractor shall ensure that truck mixers are operated in accordance with the Manufacturer's Instructions.

The Contractor shall obtain a certificate from the ready-mixed concrete manufacturer to show that all truck mixers have been tested in accordance with BS 3963 within the previous twelve months.

The Contractor shall submit for approval by the Employer's Representative, the name of the Ready-Mixed Concrete Company and details of the proposed supply, prior to the delivery of any concrete to the site.

Discharge of concrete from a truck mixer or agitator shall be completed within two hours after the introduction of cement to the mix. Where concrete is transported in non-agitating equipment, discharge shall be completed within one hour after the introduction of cement to the mix. Following the introduction of water to the mix at the Ready-Mixed Company's Works the addition of further water to the mix shall not be permitted. Prior to the placement of any concrete on site, the Contractor shall ensure that the concrete mix to be delivered shall comply with the specified mix properties, without the addition of water or any other materials, on delivery to the site. The Contractor shall also ensure that the Ready-Mixed company can deliver an uninterrupted supply of consistent concrete in order to maintain continuity of concrete placement between approved construction joints.

The Contractor shall keep complete records of delivery including the supplier's original docket receipts. Sampling and testing of the concrete shall be carried out, by the Contractor, at the point of discharge in accordance with the provisions of the Specification.

4.14 Temperature

For concreting in extreme weather, the recommendations of BS 8110: Part 1 Cl. 6.2.4 and Cl. 6.2.5. shall be followed, and further guidance may be found in BS 8500-1:2006 Annex A9. The provision of Cl. 8.14.1 and 8.14.2 of this specification shall also be adhered to.

4.14.1 Cold Weather

The temperature of concrete at the time of placing shall be at least 5°C and shall not exceed 30°C. The concrete temperature shall be measured at the most unfavourable position for the limit in question. If the air temperature is below 2°C, or if less than 5°C on a falling thermometer, no concrete shall be placed. Special care shall be taken to prevent the temperature of fresh concrete falling below 5°C when placing against previously cast concrete that is at a lower temperature.

Mixing water shall not be heated above 60°C. If it is desired to use water that is heated above 30°C the water shall first be mixed with the aggregate prior to adding the cement.

Concrete when deposited shall have a temperature of not less than 5°C. Suitable precautions shall be taken to ensure that the temperature of the concrete after placing does not fall below 5°C until it has thoroughly hardened. The method of heating the concrete or formwork shall not be such as to cause drying of the concrete. Before placing concrete, all contact surfaces including formwork, reinforcement, adjacent concrete, and the ground shall be free of ice, snow and frost damage.

In addition to the requirements of Clause 4.13 above the concrete shall be protected from frost by covering with suitable insulating material for a period of at least 72 hours where normal Portland Cement is used, or 36 hours where rapid hardening Portland Cement is used. The placing of concrete may be prohibited at any time if in the opinion of the Employer's Representative conditions are unsuitable or the proper precautions are not being taken, and not withstanding any permission which the Employer's Representative may give, all concrete damaged by frost shall be renewed by the Contractor at his own expense, and replaced by sound materials to the satisfaction of the Employer's Representative.

4.14.2 Hot Weather

In hot weather suitable means shall be provided to shield the aggregate stockpiles from the direct rays of the sun or to cool the aggregate by spraying with water and to insulate the mixing water tank and pipelines to ensure that the temperature of the concrete when deposited shall not exceed 30°C.

In hot weather suitable means shall be provided to avoid premature stiffening of concrete placed in contact with hot dry surfaces. Where necessary the surface, including reinforcement, against which

concrete is to be placed, shall be shielded from the direct rays of the sun and shall be sprayed with water to prevent excessive absorption of the surfaces of water from the fresh concrete.

4.15 Construction Joints

The Contractor shall position and form construction joints to suit the structure so as not to cause short-term or long-term distress to the structure, all to the agreement and approval of the permanent works structural designer.

Concrete placement shall be carried out continuously up to construction joints, the position and arrangement of which shall be as indicated on the drawings or approved by the Employer's Representative. Care shall be taken to ensure that the concrete adjacent to joints is adequately compacted. Concrete shall not be allowed to run to a feather edge, and vertical joints shall be formed against a stop board. Joint lines shall be arranged to coincide as far as possible with features of the finished work.

Before new concrete is deposited against old concrete or against concrete which has already reached its final set, all laitance shall be removed and the concrete shall be roughened to the extent that the larger aggregate is exposed but not disturbed.

When the concrete has set but not hardened, the surface of the joint shall be pressure sprayed with water and brushed to remove the outer mortar skin exposing, but not disturbing the larger aggregate.

Immediately prior to re-commencement of concreting at a joint, the joint surface shall be cleaned of all loose matter, wetted and coated with a layer of cement grout. The Contractor shall take particular care to ensure that concrete in the vicinity of joints is adequately compacted.

Precautions shall be taken to prevent rust staining during construction, caused by reinforcement projecting through construction joints.

All joints in Concrete Liquid Retaining Structures shall incorporate PVC waterstops from an approved Manufacturer as outlined in Volume A1.

Where waterstops are being used they shall be protected from rain or dampness prior to being placed in position and shall be fully concreted within a period of 2 weeks of their being placed in position.

All waterstops shall be used strictly in accordance with the Manufacturer's instructions with particular care being taken to hold the waterstops in place using tying wire to eyelets at 300mm (approx.) centres or to special proprietary clips at 500mm (approx.) centres as appropriate.

All jointing shall be carried out using the Manufacturer's special junction pieces and strictly in accordance with the Manufacturer's instructions.

Where waterstops within the concrete section are proposed the contractor shall submit to the employer, details of the methods to be used to ensure full compaction of the concrete around the waterstop.

4.16 Curing

Following placement, concrete shall be protected from the harmful effects of weather, water shock or any other agents which could cause distortion, efflorescence, cracking or adversely affect the strength and durability of the concrete. The methods of protection required shall be applied as soon as possible after placement and shall be of such duration as shall be specified, or directed by the Employer's Representative in order that the concrete shall have attained the necessary properties to resist damage before removal of the protection system. Care shall be taken to ensure that components intended to have a similar exposed surface finish are cured under the same conditions. Where chemical curing agents are used in water retaining structures in water treatment works and in structures containing potable water, only those agents, certified by WRC (Water Research Council) as suitable in contact with potable water, shall be used.

Concrete shall be kept damp for a minimum period of 4 days during which the temperature of the concrete exceeds 10°C. During the curing period, the temperature of the concrete shall be maintained at not less than 5°C. The curing period, during which the concrete is kept continuously damp, shall be increased by 12 hours, for every day during which the temperature of the concrete is between 5°C and

10°C. To maintain the concrete at the required temperature, adequate insulating material and windbreaks shall be provided.

To keep the concrete damp an impermeable membrane, such as polythene to be approved by the Employer's Representative, may be used to cover concrete. Care shall be taken to avoid cold water being applied to curing concrete surfaces, particularly in the case of thick concrete sections. Particular care shall be taken to prevent rapid drying out of concrete in thin sections. Concrete shall not be subject to any traffic within 7 days of placement, unless otherwise approved. Members shall not be loaded before 28 days after casting, unless otherwise approved by the Employer's Representative.

4.17 Temporary Supports During Construction

The Contractor shall be responsible for ensuring the temporary stability of all work, including both in situ and precast, during construction. Temporary supports shall take account of all construction loads, including wind, likely to occur between erection and the achievement of the final structural form.

Temporary works shall be designed by the Contractor's specialist Temporary Works Designer (TWD). The arrangement of temporary supports shall be submitted to the PSDP in advance of the works. The design shall also be submitted for approval by the permanent works structural designer. If such approval is given, this shall in no way remove responsibility of the temporary works from the Contractor. No temporary support shall be removed until requisite strength of the member and its connection has been achieved.

Work in existing buildings or near adjacent buildings or pavements and in particular excavations for foundations adjacent to existing buildings or pavements shall be carried out in such manner as will not endanger these existing buildings or pavements.

The Contractor's attention is drawn to the fact that he should comply with all Factory Acts, Health and Safety Acts, Government Regulations etc. in relation to temporary works, scaffold etc.

4.18 Trial Mixes, Sampling And Testing

4.18.1 Conformance

Testing of the concrete is to be carried out by the concrete supplier as per IS EN 206-1 with a "Declaration of Conformity" being produced for each delivery of concrete. In addition to this, Identity Testing should be carried out by the contractor to meet the requirements of Clauses 4.18 - 4.20 below, as well as meeting the minimum requirements of IS EN 206-1.

4.18.2 General

The Contractor shall be required to produce trial mixes as specified to satisfy the Employer's Representative as to the stability of materials and methods proposed for the production of concrete throughout the duration of the contract. Separate trial mixes shall be made for each type of grade of concrete and for concrete incorporating different types of constituent materials.

4.18.3 Trial Mixes

The Contractor shall arrange for trial mixes to be carried out in an approved laboratory to achieve the target mean strength for each grade of concrete and satisfying minimum cement content, workability and maximum size of aggregate requirements. The trial mixes shall contain identical constituent materials proposed for use at the works throughout the duration of the contract. Satisfactory trial mixes shall be carried out and tested in sufficient time to avoid delaying the commencement of concreting at the works. The Employer may accept as an alternative evidence of previous concrete production by the Contractor, including test results, where identical constituent materials were incorporated.

4.18.4 Tests for Trial Mixes

Sampling and testing of concrete from trial mixes shall be carried out in accordance with BS 1881, IS EN 12350 Testing fresh concrete, IS EN 12390, Testing hardened concrete and IS EN 12504-1, Testing concrete in structures, at an approved independent laboratory.

From each of the three batches produced, three cubes shall be made for testing at 28 days. The workability of each trial batch shall be determined. The trial mix proportions shall be approved if, having satisfied the other provisions of the Specification, the average strength of the nine cubes tested at 28 days (7 days guideline only) exceeds the relevant value in the Table below:

Compressive Strength Class	Trial Mix Strength (N/mm ²)	
	7 Day	28 Day
C12/15	--	26.5
C16/20	21.0	31.5
C20/25	24.3	36.5
C25/30	27.7	41.5
C28/35	31.0	46.5
C30/37	33.3	49.0

Table 8.3: Trial Mix Proportions

In certain circumstances, the Employer's Representative may accept result of 7 day tests. If these crushing strengths are exhibited the Employer's Representative may give instructions enabling the Contractor to commence concreting operations after the lapse of 7 days or 28 days as the case may be from the manufacture of the preliminary cubes.

The Contractor shall not commence concreting until these requirements have been met to the satisfaction of the Employer's Representative. The Contractor shall provide and deliver, free of charge, sample specimens to an approved laboratory. Testing shall be carried out in accordance with the BS quoted and the cost shall be charged against the Provisional Sum included in the Bill of Quantities.

Adjustments in proportions may be approved by the Employer's Representative, following sufficient evidence of cube test results, to approach more closely the target mean strength provided the other relevant requirements in relation to minimum cement content and maximum water cement ratio are complied with. Such adjustments, if approved by the Employer's Representative, may be implemented without trial mixes.

4.18.5 Ready Mixed Concrete

Where ready mixed concrete is proposed, the Contractor shall obtain test certificates from the ready mixed supplier of cube tests on trial mixes carried out in an approved independent laboratory using identical materials proposed for use in the works. Sampling and testing shall be carried out in accordance with BS 1881.

4.19 Sampling And Testing

4.19.1 General

The Contractor shall ensure that concrete used in the works shall comply in all respects with the Specification. In order to prove compliance with the provisions of the Specification, the Contractor shall implement quality control procedures to the satisfaction of the Employer. Sampling and testing shall be carried out in accordance with the provisions of BS 1881, IS EN 12350, IS EN 12390 and IS EN 12504-1 (See Note above) unless such provision is at variance with the Specification. The Contractor shall provide and deliver free of charge sample specimens, as required by the employer and in accordance with the Specification, to an approved independent laboratory. The Contractor shall arrange for testing at the laboratory in accordance with BS 1881 and again the cost shall be charged against the provisional sum, and for the test results to be forwarded directly from the laboratory to the Employer's Representative.

4.20 Identify Testing

4.20.1 Sampling

The rate of sampling from concrete production shall be agreed with the Employer's Representative and may be adjusted during the course of the contract depending on the importance of members involved and the consistency of previous test results.

In general, for large pours, one sample shall be taken from one batch, selected randomly, to represent 20 cubic metres (or 20 batches whichever is the lesser). At least one sample shall be taken on each day for each grade or type of concrete produced. Where critical members e.g. columns, cantilevers, masts, etc. or a number of varied sections are being cast, the sampling rate shall be increased to one sample from one batch, selected randomly to represent 10 cubic metres. The sampling rates specified shall apply to each type or grade of concrete produced.

Where concrete is being supplied ready-mixed, the frequency of sampling of concrete, supplied to one specification, placed continuously between construction joints, on any day or one job shall be as follows:

1 Truck	-	1 Sample
2-5 Trucks	-	2 Samples
6-10 Trucks	-	3 Samples
for each additional 10 Trucks	-	1 Sample

In addition, sampling shall be as frequent as recommended above for concrete produced at the Works.

Unless otherwise directed by the Employer's Representative, the samples shall be taken at the point of discharge from the mixer or in the case of ready-mixed concrete at the point of discharge from the delivery vehicle. Three test cubes shall be prepared for each sample. The cubes shall be made, cured, stored and transported in accordance with BS 1881. The tests shall be carried out in an approved independent laboratory. Cubes from each sample will be identified clearly with the date of casting and sample reference. Accurate records shall be kept of all concrete cast with reference to samples taken so that each concrete member or section of a member is represented by one sample, which can be readily identified at any time. The three cubes for each sample shall be designated as A, B and C; for example the three cubes for Sample No. 100 will be designated as 100A, 100B and 100C.

4.20.2 Testing

From each sample one cube (Cube A) shall be tested at 7 days and two cubes (Cubes B and C) shall be tested at 28 days, unless otherwise directed by the Employer's Representative. The cubes shall be tested in accordance with BS 1881. The average of the two cubes tested at 28 days shall be taken as the test result. The Contractor shall arrange for copies of test results to be forwarded directly from the approved Independent Laboratory to the employer, not exceeding 48 hours after the tests have been carried out. If the cube tested at 7 days fails to exceed the 7 day min. works cube strength the Contractor shall take steps to increase the concrete strength to the Employer's Representative satisfaction.

4.20.3 Compliance

Compliance with the characteristic strength shall be assumed if both conditions are;

below are met by test results based on 28 day tests.

The average strength determined from any group of four consecutive test results shall exceed the value indicated in the Table below:

Compressive Strength Designation	Average Strength (N/mm ²)
	(Four Consecutive Results)
C12/15	17
C16/20	23
C20/25	28
C25/30	33
C28/35	38
C30/37	41

Table 8.4: Trial Mix Proportions

AND

The strength determined from any test result shall not be less than the value of the minimum strength indicated in the Table below:

Compressive Strength Designation	Average Strength (N/mm ²)
	(Any Test Result)
C12/15	13
C16/20	17
C20/25	22
C25/30	27
C28/35	32
C30/37	34

Table 8.5: 28 Day Compressive Strength

In the event of non-compliance with condition (a) above, then all of the concrete in all batches represented by the Group of the four consecutive test results shall be deemed not to comply with the strength requirements. This shall include the batches of concrete from which the first and last samples, of the group of four, were taken and all intervening batches.

In the event of non-compliance with condition (b) only, then only the particular batch from which the sample was taken shall be deemed not to comply with the strength requirements.

If more than one test result in a group of four fails to comply with condition (b) then all of the concrete in all batches represented by the group of the four consecutive results shall be deemed not to comply with the strength requirements.

4.20.4 Early Tests

The results of the cube tests at 7 days shall comply with both of the following conditions:

The average strength determined from any group of four consecutive cube tests shall exceed the value indicated in the Table below:

Compressive Strength Designation	Average Strength (N/mm ²)
	7 Day Test (Four Consecutive Results)
C16/20	18.3
C20/25	21.7
C25/30	25
C28/35	28.3
C30/37	30

Table 8.6: Average 7 Day Compressive Strength

AND

The strength determined from any cube test shall not be less than the value indicated in the Table below:

Compressive Strength Designation	Minimum Strength (N/mm ²)
	7 Day Test (Any Cube Test)
C16/20	13.3
C20/25	16.7
C25/30	20.0
C28/35	23.3
C30/37	24.6

Table 8.7: Minimum 7 Day Compressive Strength

The values given in the above Tables apply to ordinary structural concrete produced using normal Portland Cement and free from admixtures and cured under normal conditions. In the event of non-compliance with either Conditions (a) or (b), the Contractor shall immediately adjust the concrete mix design to increase its characteristic strength to the satisfaction of the Employer's Representative. In addition, the Contractor shall be required to carry out remedial measures to the concrete, represented by the cube test or group of tests, as directed by the Employer's Representative.

Action in the Event of Non-Compliance of 28 Day Test Results:

In the event of concrete being deemed not to comply with the strength requirements, the Contractor may be required to remove the concrete and shall take whatever remedial measures, as directed by the Employer's Representative, to sections of the structure affected by the non-complying concrete.

The Employer's Representative may, alternatively, in less severe cases, direct that the Contractor retain the concrete carrying out remedial works as directed by the Employer's Representative.

The Employer's Representative may require the Contractor to arrange for tests to be carried out on the non-complying concrete. The results of any such tests shall not nullify the establishment of non-compliance with the strength requirements. Any work to be carried out by the Contractor as a result of non-compliance, shall be done at the Contractor's own expense.

4.20.5 Quality Control

The Contractor shall arrange to carry out Quality Control procedures in accordance with BS 1881, IS EN 12350, IS EN 12390 and IS EN 12504-1 (See Note Above).

The Contractor shall install a maximum / minimum thermometer in an approved position on site to record air shade temperatures, as follows:-

The maximum and minimum overnight air temperature each night.

The air shade temperature at three approved times each day.

From each sample of fresh concrete, one specimen shall be tested for consistence. The permissible deviation for slump for designed mixes shall be:

Plus/minus 25mm or plus/minus one third of the specified value whichever is the greater.

Slump testing should also satisfy the requirements of IS EN 206-1.

Where concrete pavements are machine laid, the Compacting Factor Test shall be used. The permissible deviation for the compacting factor shall be within plus / minus 0.03 of the specified value.

The air content of air entrained concrete in pavements shall be determined at least 6 times per day. If the air content determined in any test falls outside the limits of 4.5 plus / minus 1.5 per cent, a further test shall be carried out immediately and the average and range of the two results shall be calculated. If the average value falls outside the limit of 4.5% +/- 1.5% or if the range exceeds 2%, no further concreting shall take place until the contractor takes steps to adjust the air content of the concrete to the satisfaction of the Employer.

The accuracy of air entrainment agent dispensing equipment shall be checked each day before concrete mixing commences. Where air entrainment is incorporated in concrete, strict control of water content shall be enforced by taking fresh concrete samples from which specimens will be tested for water content. In addition, compacting factor tests shall be carried out on specimens from the same samples.

As soon as the Employer's Representative is satisfied with the consistency of test results and a correlation is established between the water content and the compacting factor, the frequency of water content tests may be reduced as directed by the Engineer. The cement content of each batch of concrete shall not be less than the specified minimum value minus 5% of the value, nor more than specified maximum value plus 5% of that value.

NOTE: No traffic whatsoever shall be allowed over any part of the finished concrete or other work until it has set and been properly protected to the satisfaction of the Employer's Representative.

4.21 Declaration Of Conformity

As well as conforming to all of the strength criteria outlined above (Clauses 4.18 – 4.20), the contractor will also be required to produce for each delivery of concrete a 'Declaration of Conformity' from the supplier.

4.22 Formwork

4.22.1 Materials

Formwork shall be constructed to timber, steelwork or other approved material, to suit the surface finish required.

4.22.2 Design

Formwork shall be designed and constructed so that concrete can be properly placed and thoroughly compacted, to ensure that all concrete elements shall be constructed within the limits of Table 1, of BS 5606, Code of Practice for Accuracy in Building.

Formwork shall be firmly supported and adequately struted, braced or tied. It shall be capable of adjustment to the lines and dimensions of the finished concrete, and it shall be sufficiently strong to resist, without excessive distortion, the pressure of concrete during its placing and compaction, and other loads to which it may be subjected. It shall not be liable to suffer distortion under the influence of the weather.

4.22.3 Deflection and Camber

The Contractor shall make allowances for any settlement or deflection of the formwork that is likely to arise during construction so that the hardened concrete conforms accurately to the specified line and level. The Contractor shall also make allowances in the formwork for any camber specified by the Engineer.

4.22.4 Supports

Formwork shall be constructed so that the formwork to the sides of the members can be removed without disturbing the soffit formwork and its supports. Props and supports shall be designed to allow the formwork to be removed in an approved sequence without injury to the concrete. Re-propping shall not be permitted.

4.22.5 Joints and Edges

All joints in formwork shall be close-fitting to prevent leakage of grout from the concrete. At construction joints formwork shall be tightly secured against previously cast or hardened concrete to prevent the formation of stepping or ridges in the concrete.

Formwork shall be constructed to provide straight and true angles, arises or edges. Where chamfers are shown on the drawings, the fillets shall be accurately cut to size to provide a smooth and continuous chamfer.

Formwork panels shall have true edges to permit accurate alignment at sides and provide a clean line at construction joints in the concrete. Formwork panels shall be fixed with their joints either vertical or horizontal, unless otherwise specified.

4.22.6 Ties

The material and position of any ties passing through the concrete shall be to the Engineer's approval. Unless otherwise approved, it shall be possible to remove a tie so that no part of it remaining embedded in the concrete shall be nearer to the finished surface of the concrete than the specified thickness of the cover to the reinforcement. Any holes left after the removal of ties shall be filled with concrete or mortar of approved composition and neatly trowelled to give the desired fair finish.

In water retaining structures, methods of fixing formwork which result in holes through the concrete section when formwork is removed shall not be used. Ties used shall be of a type to maintain water resistance of the construction.

4.22.7 Cleaning and Treatment of Formworks

All rubbish, chippings, shavings, sawdust and dirt shall be removed from the interior of the formwork, before concrete is placed. The formwork to be in contact with the concrete shall be cleaned and either thoroughly wetted or treated with a suitable mould oil or approved composition. Care shall be taken that oil or composition is kept from contact with the reinforcement or with concrete at any construction joints. Retarding Agents shall not be used except with the permission of the engineer expressly given in writing. Formwork shall be thoroughly cleaned after each use. Damaged or distorted formwork shall not be used. Where any chemical agents are used to coat the formwork faces in water retaining structures in water treatment works and in structures containing potable water, only those agents, certified by WRC (Water Research Council) as suitable in contact with potable water, shall be used.

4.22.8 Striking or Removal of Formwork

All formwork shall be removed without shock or vibration that might damage the concrete. Before the soffit and props are removed, the surface of the concrete shall be exposed where necessary, in order to ensure that the concrete has hardened sufficiently. In no circumstances shall the formwork be struck until the concrete reaches a cube strength of at least twice the stress to which the concrete may be subject at the time of striking.

The exact sequence of propping and backpropping through the structure shall be set out in a method statement prepared by the contractor and shall be agreed with the engineer in advance.

In general, unless otherwise specified by the Engineer, the minimum period for retaining formwork in position, shall be as listed in the Table below:

Formwork Element	Temperature	
	Above 7 Deg. C	Above 16 Deg. C
Vertical Formwork to Columns, Walls and Beams	12 Hrs.	12 Hrs.
Soffit Forms to Slabs	7 Days	4 Days
Props to Slabs	14 Days	11 Days
Soffit Forms to Beams	14 Days	11 Days
Props to Beams	21 Days	15 Days

Table 8.8: Minimum Period Before Striking of Formwork

For the purpose of the above Table, the temperature shall be the surface temperature of the concrete. Days during which the concrete surface temperature falls below 3 Deg. C. shall not be taken into account in the above Table. For each day, during which the concrete surface temperature is generally between 3 Deg. C and 7 Deg. C a half of a day shall be added to the period listed in the above Table. Where lintels or other precast concrete members, depending on composite action, are incorporated, props shall be used and kept in position, until the construction above has reached adequate strength as approved by the Employer's Representative.

Should the Contractor wish to strike the shutters earlier than the times mentioned in the above Table, he will be required to confirm by means of 3 Cube tests, that the concrete has attained a minimum strength agreed with the Employer's Representative.

The Contractor shall be responsible for any injury to the concrete work and for damage caused by, or arising from the removal and striking of the forms and supports. Any advice, permission or approval given by the Employer's Representative, relative to the removal and striking of forms and supports, shall not relieve the Contractor from responsibility.

4.22.9 Formed Surfaces – Classes of Finish

Class F1:

This finish is to be used for surfaces against which backfill will be placed.

Formwork shall consist of rough finish formwork as described in Clause 4.2.8 above of the Specification.

Class F2:

This finish is to be used for exposed surfaces. Formwork shall consist of fair finish formwork as described in Clause 4.2.8 above of the Specification. This finish shall be such as to require no general filling of surface pitting, but fins, surface discolouration and other minor defects shall be remedied by methods approved by the Employer's Representative.

Class F3:

This finish is to be used for surfaces prominently exposed to view where good appearance and alignment are of special importance. Formwork shall be faced with resin bonded plywood or metal panels, free from defects, in large sheets. Joints between sheets shall be arranged to coincide with architectural features wherever possible, and shall be vertical and horizontal unless otherwise directed by the Employer's Representative. The decision of the Employer's Representative as to what constitutes finish to Class F3 is final and without appeal and any concrete failing to produce fair finish will be rejected.

4.22.10 Unformed

Class U1:

This is a floated finish for surfaces of slabs to receive a tiled or similar finish or expose slabs where a hard smooth steel trowelled finish is not specified. Floating shall be done only after the concrete has hardened sufficiently and may be done by hand or machine. Care shall be taken that the concrete is worked no more than is necessary to produce a uniform surface free from screed marks.

Class U2:

This is a hard smooth steel trowelled finish for exposed surfaces of slabs where required by the Employer's Representative. Trowelling shall not commence until the moisture film has disappeared and the concrete has hardened sufficiently to prevent excess laitance from being worked to the surface. The surface shall be trowelled under firm pressure by hand or by machine and shall be left free from trowel marks.

Except where Class U1 and Class U2 special finishes are specified, all concrete unformed surfaces shall be levelled and screeded to produce a uniform plain or ridged surface surplus concrete being struck off by a straight edge immediately after compaction. This shall also be the first stage for Class U1 and Class U2 special finishes.

4.22.11 Openings in Walls and Slabs

Openings through concrete walls and slabs (including those openings to facilitate the installation of pipes/ducts through the walls and slabs) shall be formed, using suitable shuttering, prior to the placement of concrete. The location and size of these formed openings shall be in accordance with the detailed drawings (Civil, Structural and Mechanical & Electrical Services drawings) and to be provided during the course of the works.

For isolated openings, up to a maximum of 150mm diameter, the permanent works structural designer may approve, subject to his confirmation prior to the pouring of the relevant concrete element, the coring of walls or slabs, using methods approved by the permanent works structural designer. In such cases, it shall be the Contractor's responsibility to ensure that reinforcement is located (or additional reinforcement is provided) to avoid cutting the reinforcement in such a coring operation. Coring of beams or columns shall not be permitted.

4.23 Air Entrainment In Concrete Pavements

An air entraining agent shall be incorporated in the concrete used in the construction of at least the top 50mm of paving to be used as a running surface. The total quantity of air in air-entrained concrete for paving shall be 4.5% +/- 1.5% by volume of the mix. Additional admixtures shall not be used in concrete containing an air entraining agent.

4.24 Cleaning Of Structures

On completion of construction and before any sterilisation, internal surfaces of structures designed to retain an aqueous liquid shall be cleaned thoroughly in such a way as to remove all oil, grit and other deleterious matter.

5 Structural Steelwork

5.1 General

5.1.1 Structural Steelwork

Structural steel generally shall conform to BS EN 10025: "Hot Rolled Products of Structural Steels". Structural sections shall be in accordance with BS4, Part 1.

Steel for structural hot finished hollow sections shall comply with BS EN 10210.

Cold formed hollow sections shall be in accordance with BS EN 10219. Steel for Structural hot-rolled angle sections shall comply with BS EN 10056. Unless otherwise specified, the use of all Structural Steelwork shall be in accordance with BS 5950: "Structural Use of Steelwork in Building".

All structural steelwork shall be grade S275JR for internal steelwork and grade S275Jo for external steelwork to BS EN 10025 unless noted otherwise. Structural hollow sections shall be grade S275 J2H to BS EN 10210.

Unless noted otherwise, all steelwork shall be in accordance with the National Structural Steelwork Specification for Building Construction, Latest Edition, published by The British Constructional Steelwork Association Ltd. and the Steel Construction Institute.

5.1.2 Cold-formed Galvanised Steel Sections

All cold-formed sections (purlins, cladding, rails, eaves, beams, etc.) are to be manufactured from hot-dip galvanised steel to BS EN 10326 and BS EN 10143.

Steel sections to be formed from minimum grade S390GD with Z275 zinc coating giving an average coating thickness of 0.02mm to each side.

5.2 Fabrication

5.2.1 Notification of Commencement

A minimum period of 10 working days are required for approval of fabrication drawings.

A minimum period of 5 working days are required before fabrication is due to start.

5.2.2 Identification Marks

Identification marks on structural steel to be visible for checking after erection but should be on surfaces not exposed to open view in the completed work.

5.2.3 Hard Stamping

Not permitted unless indicated on drawings.

5.2.4 Welding

Welding of structural steelwork shall be in accordance with BS EN 1011. All welding shall be carried out by approved coded welders. Certificates for the welders shall be submitted to the Permanent Works Structural Designer.

Site welding only permitted where indicated on drawings and in suitable welding conditions.

Welds to be carefully dressed to remove slag. Do not deform surface of weld.

Testing of welds shall be carried out in accordance with the requirements of the latest edition of "National Structural Steelwork Specification for Building Construction" published by the BCSA and SCI (Publication No. 203/02), Section 5 "Workmanship – Welding", Section 5.5 "Non-Destructive Testing of Welds".

5.3 Erection

5.3.1 Pre-Erection Checks

At least 7 days before the proposed erection start date the following should be checked:

- Foundation and other structures that steelwork will be fixed to.
- Accuracy of setting out.
- Position, protruding length, slackness and condition of holding down bolts. Inaccuracies should be reported immediately. Permission to commence erection should be obtained.

5.3.2 Temporary Works

Temporary works are the responsibility of the contractor. All temporary works are to be designed by a competent temporary works designer, and designs, together with method statements for erection should be submitted to the Permanent Works Structural Designer for comments prior to the commencement of any construction activities.

5.3.3 Bolting

Black bolts shall conform to BS 4190 or equivalent. Grade 8.8 High Precision Tensile Bolts shall conform to BS 3692 or equivalent. High strength friction grip bolts shall conform to BS EN 14399 or equivalent. Steel washers shall comply with BS 4320 or equivalent. All bolts shall be grade 8.8 unless noted otherwise.

The use of high strength friction grip bolts shall be in accordance with BS 4604-1 or equivalent.

5.3.4 Holding Down Bolts

The contractor shall provide holding down bolts for the Building which shall comply with BS 7419 and shall be hot-dip galvanised to BS EN ISO 1461. The exact position of the holding down bolts is to be coordinated between the Steel Fabricator and the Contractor. The holding down bolts are to be cast in the agreed positions by the Contractor. The steel fabricator shall be required to supply and install the steel structure to suit the fixed location of these bolts, and shall check dimensions on site prior to finalising fabrication.

5.3.5 Grout Under Base-Plates

Holding down bolt sleeves and the nominal 20mm gap under base plates shall be completely filled and grout up respectively using non-shrink grout.

Non-shrink grout requirements:

- Final strength (28 Days) >80 Mpa
- No volume loss
- Shrinkage <1.2mm/m (23°C/50% Relative Humidity)

The Tenderer shall include for all works and materials associated with this grouting including shuttering of the grouted areas. The grout shall be installed strictly in accordance with the Manufacturer's recommendations. The Tenderer will include for the provision of all steel shim plates required to level the structure prior to grouting.

5.4 Protective Treatment – General

Steel not to be coated with protective treatment shall be:

- Steel encased in concrete.
- Top flange of steel beam to receive shear studs.

All internal structural steel work to be treated as follows unless noted otherwise:

- Remove by chipping, scraping and wire brushing loose rust and scale, welding slag and splatter from steel surfaces. Clean out crevices. Remove oil, grease and dirt.
- Prepare by blast cleaning the steel surface to give preparation grade of surface quality Sa 2½ in accordance with BS 7079 or equivalent.
- Apply high build Zinc phosphate epoxy primer to minimum 80µm thickness.
- Where site welding to treated structural steel occurs, appropriate post treatment is required to achieve the original standard of preparation and coating.
- For shop made black bolted joints, the appropriate primer should be applied to contact surfaces prior to assembly in the shop. For site made joints, where shop primer has been applied, no further treatment is required before assembly. For site joints that have not been primed in the shop the appropriate primer should be applied prior to assembly.
- For high strength friction grip bolted joints, faying surfaces at the time of assembly must be free of any contaminant which would prevent the development of the slip factor required of the joint. After tightening and inspection of the bolt groups, the crevices around the load indicating washers, bolt heads, edges of the faying surface etc. should be sealed if necessary with the compatible paint or mastic. The nuts and bolts should then be cleaned, and the full coating system applied. All external exposed structural steelwork, including bolts shall be treated as follows unless noted otherwise.
- Remove by chipping, scraping and wire brushing loose rust and scale, welding slag and splatter from steel surfaces. Clean out crevices. Remove oil, grease and dirt.
- Grit blast the steel surface to BS 7079 using chilled angular iron grit of size G24.
- Steel Hot Dipped Galvanised to BS EN ISO 1461 with minimum nominal coating thickness of 85 µm.
- No site welding of galvanised steel will be allowed.

5.5 Protective Treatment – Fire

Fire protection method and fire rating period will be as per the Architects specification. Fire protection system should be in accordance with “Fire Protection for Structural Steel in Buildings” latest edition produced by the Steel Construction Institute and the Association for Specialist Fire Protection.

The fire protection system is to be applied in accordance with the manufacturer's details.

N.B. All steel fabrication is to take place at the suppliers works, no drilling/cutting/welding is to take place on site, proprietary block ties for blockwork to stanchions connections are to be provided.

N.B. Compatibility should be ensured between the fire protection paintwork and the architectural paint finish on the steelwork.

5.6 Additional Considerations

Tenderers must take into account and include in their tender for any adjustment to the structural members required by the fabrication, galvanising, painting, transport and erection processes.

The tender must include for all necessary temporary bracing required during the erection process.

Steelwork fabrication drawings must be approved by the Permanent Works Structural Designer prior to fabrication.

The Contractor shall be responsible for checking all relevant dimensions on site prior to fabrication of steelwork to ensure that all elements of the structural steelwork, etc. tie in with all the remaining elements of the building.

5.7 Profiled Steel Sheetting

Profiled steel sheetting and cladding shall comply with BS 449, BS 476, BS 5427: Part 1 and BS 5950

6 Structural Timber

All timber used in the permanent works shall be new.

Timber for structural use shall comply with the requirements of IS 444, published by the National Standards Authority of Ireland.

Minimum Structural Strength Class of timbers to be Class C16 of BS 5268: Part 2, Table 2 and IS EN 388.

Preservative treatment of timber for structural purposes shall comply with the relevant provisions of BE 5268, Part 5.

6.1 Timber Fasteners And Fixings

6.1.1 Nails

Nails shall comply with the relevant provisions of the appropriate Standards as set out below:

Nails Standards		
Type	BS	IS
Steel	1201, Part 1	IS 105 Part 1
Copper	1202, Part 2	IS 105 Part 1
Aluminium	1202, Part 3	IS 105 Part 1

Table 7.1: Nails Standard

6.1.2 Wood Screws

Wood screws shall comply with the relevant provisions IS 97 or BS 1210.

6.2 CONNECTORS FOR TIMBER

Connectors for timber shall comply with the relevant provisions of IS EN 912.

6.3 WORKMANSHIP

6.3.1 Carpentry and Joinery

Insofar as is possible, cutting and shaping of all timber shall be completed before preservative treatment is carried out. Where any cutting or shaping has to be carried out after treatment, the surfaces so cut or worked shall be given 2 coats of the preservative. After treatment, timber shall be thoroughly dried out before use.

The whole of the joinery shall be cut and framed together as soon after the commencement of the work as possible and workmanship shall comply with the relevant provisions of BS 1186: Part 2 and BS 6446. Except where work is shown in the contract as being to finished sizes, 3mm shall be allowed for each wrought face. Framed casings and other joinery and fittings shall be secured to hardwood fixing slips built in for the purpose. Where hardwood fixing slips have not been provided, receiving surfaces shall be plugged with hardwood plugs or approved proprietary type plugs.

Manufactured units to be painted shall be primed at the place of manufacture.

All joinery, including sections which have been primed or treated with preservative, shall be properly stacked and protected from the weather until erection.

Where timber is described as pressure-impregnated it is to be vacuum/pressure-impregnated with Chromated Copper Arsenate (e.g. Tanalith C) preservatives to a nett dry salt retention of 4kg. Chromated

Copper Arsenate per cubic metre of timber, or other similar and approved process. Timber to be pressure-impregnated must be machined to its final dimensions. Where cross-cutting, notching and boring after treatment cannot be avoided all exposed surfaces should be liberally swabbed with preservative. Rip sawn pieces must be re-treated.

6.4 Timber Structure

6.4.1 Roofs

Wall plates for roofs shall be halved and lapped at joints and fixed to walls.

Roof members shall be wedged, and bolted or spike jointed with connectors as specified.

Flats and gutters shall be covered with Type WBP plywood or tongued and grooved wrought boarding laid diagonally, fixed to falls of not less than 1 in 120 for lead and copper and 1 in 60 for bitumen felt.

Holding down straps comprising 50x 5, galvanised steel straps shall be provided at average centres of 1.2m overall but located between the windows. These straps shall be fixed to the rafters and wallplate using square twist sherardised nails (minimum 3 No. 32, long x 9swg.). The straps shall extend a minimum of 1.2m down below the level of the wallplate and be fixed to the wall with a minimum of 4 No. 8 x 50mm screws, drilled, plugged and screwed to the wall. These screws shall be located within 500mm of the bottom of the strap.

Roof trusses shall be fixed to 100mm x 75mm wallplates which shall be fixed to the blockwork of the inner leaf. The timber-trussed rafter shall be tied at the apex continuously with 100mm x 25mm timber ties.

Longitudinal ties 100mm x 25mm shall be provided and fixed transversely to the ceiling ties (or bottom of members of the trusses).

Diagonal braces 100mm x 25mm shall be provided to all slopes of roof trusses. All the work shall be carried out strictly in accordance with Irish Standard Specification IS 193 and in accordance with detail drawings.

Projection of roof at eaves and verges shall be 300mm measured horizontally from ends of rafters to external face of wall. Closed soffits shall be provided to all roof projections.

Timber shall be softwood pressure treated with organic based preservative to BS 5268 Part 5 (Preservative Treatments for Constructional Timber). Maximum water content permissible at time of erection is 22% in accordance with IS 96 (Moisture Content to Timber for Building).

On top of the rafters, untreatable roofing felt to IS EN 13707 shall be secured with 50mm x 38mm counter battens for reception of slates. The battens are to conform to the requirements of IS 96 (Moisture Content of Timber for Buildings). The roofing felt shall be lapped 150mm horizontally and 150mm vertically.

Roof tiles shall be plain roof tiles or similar approved conforming with requirements of IS EN 490 "Concrete Roofing Tiles and Fittings for Roof Covering and Wall Cladding". The colours of the tiles shall be approved by the Employer's Representative prior to the commencement of the construction of the building based on samples to be provided by the Contractor. They shall be laid with a lap of 100mm and fixed to battens at 250mm centres.

The Contractor is solely and wholly responsible for the presentation of a finished roof obviously executed by skilled tradesmen and nothing less than the highest standard of finish will be acceptable to the Employer's Representative.

All mortar used in the roof shall be 1:3 cement mortar coloured by the addition of carbon black or an acceptable dye so that it will blend in with the colour of the tiling.

7 Pipelines

7.1 Pipelaying Generally

The location of pipelines in roads will generally be as described in the Drawings but the actual final position will be agreed on site with the Employer's Representative Site Staff.

Where socketed pipes are required to be laid on a granular bed joint holes shall be formed in the bedding material to ensure that each pipe is uniformly supported throughout the length of its barrel and to enable the joint to be made.

Pipes shall be laid on setting blocks only where a concrete surround or cradle is used.

No protective cap, disc or other appliance on the end of a pipe or fitting shall be removed permanently until the pipe or fitting that it protects is about to be jointed. Pipes and fittings, including any lining or sheathing shall be examined for damage and the joint surfaces and components shall be cleaned immediately before laying. Pipes shall be laid with the sockets facing upstream and starting at the downstream end of the trench. Suitable measures shall be taken to prevent soil or other material from entering pipes, and to anchor each pipe to prevent flotation or other movement before the works are complete.

The Contractor shall prevent disturbance or softening of wet fine grained soils such as clays, silts and fine sands in the trench bottom, by proper drainage and by placing a blanket of coarse sand and gravel or other approved granular bedding material on the virgin formation as soon as it is uncovered. No traffic shall be allowed in the trench bottom until the blanket is in place. In very soft ground this blanket shall be additional to the normal bedding required for the pipe. Extra soft spots shall be hardened to the general condition of the bottom by tamping in granular material before continuing with the blanket.

Peat or boggy material below formation level shall be removed and replaced by broken stone or other approved stable filling material.

In special situations piling may be specified.

In mixed soils containing large boulders, stones or flints, any object which is near enough to the bottom to form a hard spot shall be removed and replaced by granular material.

Where the flow of ground water is likely to transport fine soil particles, water stops of puddle clay extending up through the bedding and surround fill shall be placed across the trench at intervals along the line.

All work shall be performed in the dry and during the construction of pipelines the Contractor will be required to provide adequate means, including pumping from specially constructed sump holes if necessary, to keep the open trenches free from water. By whatever means appear appropriate the Contractor shall arrange the discharge of trench drainage into natural watercourses and shall take all necessary precautions to ensure that no nuisance is thereby caused to downstream riparian owners. When no longer needed, temporary drains shall be sealed permanently by grouting, and any sumps formed for pumping ground water shall be filled with well compacted selected material as for the bedding.

It is expressly stipulated that the Contractor may not pollute the waters of streams, lakes or other water courses which are adjacent to the works, and if heavily silted water is pumped from the trenches, the discharge shall be so arranged that the silt will not foul watercourses into which the drainage is conveyed. Silt traps or other suitable means to a design to be approved by the Employer's Representative shall be constructed to assist in this matter.

7.2 Setting Out Of Watermains, Sewers And Other Pipelines

The Contractor shall be responsible for the proper setting out of the pipelines, which shall be laid to their proper levels and grades with the aid of a pipe laying laser.

In the case of twin pipe trenches a separate laser instrument shall be used on each pipeline. Pipelaying lasers shall be self-levelling with digital read out of grade and with an accuracy of not less than 0.01%.

Accessories shall include suitable base plates and targets for the smaller diameter pipes up to 400mm diameter. For the larger diameter pipes up to 1800mm diameter suitably fabricated supports and

centering devices shall be provided to allow for accurate setting of the instruments either on the invert of the pipeline or on the centreline.

7.3 **Materials In Contact With Potable Water**

All materials, substances and products in contact with potable water shall be on the Approved List published by the UK Drinking Water Inspectorate (or other equivalent European approval system). The Contractor shall provide a list of all substances, products and processes which he proposes to use and which may come into contact with potable water, and written confirmation of DWI approval (or other equivalent European approval). If the list submitted includes an unapproved substance, product or process the substitution of that unapproved substance, product or process with an approved one shall be at the Contractor's expense.

7.4 **Pvc Pipes And Fittings**

PVC pressure pipes, joints and fittings shall comply with the relevant provisions as set out below:

PVC Pipes and Fittings		
Materials	Pipe	Joints and Fittings
PVC-U (metric blue)	IS EN 1452-2	IS EN 1452-3
PVC-A	PAS 27	PAS 27
PVC-O	WIS 4-31-08 (12.5 bar and 16 bar only)	IS EN 1452-3

Table 8.1: PVC Pipes and Fittings

Pipes for potable water use shall be coloured blue.

Unplasticised PVC pipes, joints and fittings for gravity sewers and drains shall comply with the relevant provisions of BS 4660, BS 5481 or IS EN 1401-1.

Unplasticised PVC Sewer Pipes shall only be used in House Connection lines and in the connection of road gullies unless otherwise stated in Section 1.

Solvent cements for jointing unplasticised PVC pipes shall comply with BS 4346: Part 3 or IS EN 1452. For pipes and fittings complying with BS 4660, solvent cement may alternatively comply with BS 6209.

Solvent cements for jointing unplasticised PVC pipes shall not be used for below ground use.

Push-fit joints shall be spigot and socket.

Twin-walled thermoplastic pipe with external corrugations shall comply with WIS 4-35-01 and BS 4660. The jointing system shall be of the compression type and bi-directional. Twin-walled thermoplastic pipe shall meet the leak tightness requirements of method 4 of IS EN 1277.

7.5 **Polyethylene Pipes (Mdpe And Hdpe)**

Medium Density and High Density Polyethylene Pipes (MDPE and HDPE) shall comply with IS EN 12201 for Water Supply and IS EN 13244-2 for Drainage and Sewerage applications.

7.6 **High Performance Polyethylene Pipes (Hppe)**

High Performance Polyethylene Pipes (HPPE) shall be made from the material which has been granted Department of Environment (UK) approval and shall be manufactured in accordance with Water Industry Specification 4-32-17 or equivalent.

This pipe system should be capable of performing within the requirements of the classification of P.E. 100 so as to enable the design of 16 bar and 10 bar systems.

7.7 Pipes For Land Drainage And Temporary Drains

Pipes, joints and fittings for land drainage and temporary drains shall comply with the relevant provisions of the appropriate Standard as set out below:

Standards	
Type	Standard
"Perforated" or "Surface Water" vitrified clay pipes and fittings	IS EN 295:5 or BS 65
Concrete Porous Pipes for Under Drainage	BS 5911: Part 114
Clayware Field Drain Pipes	BS 1196
Plastics Pipes for use as Light Duty Sub-Soil Drains	BS 4962
"Land Drainage" category concrete pipes and fittings with ogee joints	BS 5911: Part 110

Table 8.2: Standards

7.8 Pipes For Ducts

Pipes, joints and fittings for exposed ducts for building services shall comply with the relevant provisions of the appropriate Standard as set out below:

Standards	
Type	Standard
Unplasticized PVC pipe	BS 3505 or BS 3506
Hollow steel sections (greater than 150mm OD)	IS EN 10210-2
Steel tubes (not greater than 150mm OD)	IS EN 10296-1 and IS EN 10305-4

Table 8.3: Standards

Pipes, joints and fittings for buried ducts shall have flexible mechanical joints and comply with the relevant provisions of the appropriate Standard as set out following:

Standards	
Type	Standard
Vitrified Clay	BS 65
Unreinforced or reinforced concrete	BS 5911
Unplasticised PVC	BS 4660 or BS 5481 and IS EN 1401-1
Structured wall pipes	IS EN 50086-2-4

Table 8.4: Standards

Cable ducts are to be laid with sand bed and surround giving a cover of not less than 80mm under and around the pipe.

All ducts terminating in buildings shall extend 150mm above slab level.

Drawcords shall be inserted in all ducts. After installation of the drawcord the duct shall be plugged and the cord fastened at each end of the duct. Draw Cord for duct threading shall be 8mm diameter, 3 strand hawser laid polypropylene rope complying with BS EN 696, BS EN 699, BS EN 700 and BS EN 701.

Separate ducts shall be laid to receive power and telemetry flowmeter cables.

Flowmeter cable ducts shall be uPVC Class B pipes to IS 123 (100mm duct 4.10mm minimum wall thickness), jointed with compression ring flexible joints and laid with sand bed and surround giving a cover of not less than 80mm under and around the pipe. Cable ducts should be protected until such time as they are brought into operation, to prevent the entry of vermin. The Contractor will ensure that:

- Each duct is cleaned and its ends **sealed** using **end caps** or foam and plastic bags so as to avoid ingress of grit, stones and sediment which can block ducts and damage cables.
- ducts are installed as per the required standards shown.

- ducts are installed so as to achieve a minimum clearance of **300mm** from all other services is maintained.

7.9 Pipe Jointing Generally

Pipe jointing surfaces and components shall be kept clean and free from extraneous matter until the joints have been made or assembled. Care shall be taken to ensure that there is no ingress of grout or other extraneous material into the joint annulus after the joint has been made.

Where pipes with flexible joints are required to be laid to curves, the deflection of any joint as laid shall not exceed three quarters of the maximum deflection recommended by the Manufacturer. This is to allow residual deflection capacity in the event of settlement of bed or backfill material.

Where Polyethylene (HDPE, HPPE) pipes are specified, a fully welded system shall be used and the number of joints minimised. Mechanical or electrofusion joints shall not be used unless expressly specified in Section 1.

Proprietary joints shall be made in accordance with the manufacturer's instructions.

7.10 Welded Joints In Polyethylene Pipes

Electrofusion and butt-fusion jointing shall be made strictly in accordance with WIS 4-32-08 using equipment specified in WIS 4-32-16.

Where PE barrier or co-extruded pipes are used the jointing system adopted shall be in accordance with the pipe manufacturer's specification and all protective systems shall be made continuous across the joint.

The pipe section containing the completed weld shall achieve at least the same strength characteristics as the parent pipe.

Fusion welded joints in high density, medium density and high performance polyethylene pipes shall be made only between pipes having the same physical characteristics. Joints between pipes of different Manufacturers shall only be made with the specific approval of the Employer's Representative.

Jointing shall be carried out by means of the Butt Fusion Jointing Technique using a fully Automatic Butt Fusion Machine with data print out. A data printout for each completed joint shall be made available for inspection by the Employer's Representative Site Staff. The jointing of the pipes which must be carried out in an approved manner under a protective hut or covering shall be undertaken by an experienced Firm who must have the prior approval of the Pipe Manufacturer and of the Employer's Representative. The experienced Firm must have a Technician or other approved person and the appropriate equipment on site for jointing of the pipe and butt fusion welding. Following completion of the jointing system it is specified that each joint shall be required to be de-beaded internally in the pipeline and this work shall also be carried out under the supervision of and with the appropriate machines provided by the same experienced Firm.

Destructive testing is to be done by preparing samples and subjecting these to test as specified in WIS 4-32-08. The frequency and type of tests shall be as follows:

- Electrofusion Welds: Short Term Burst Test as per Appendix A of WIS 4-32-08 and Joint Toughness: Double Cantilever Cleavage Test as per Appendix C of WIS 4-32-08 each carried out at a frequency of 1 test per 30 joints made on site.
- Butt Fusion Welds: Ductility: Tensile Test as per Appendix B of WIS 4-32-08 carried out at a frequency of 1 test per 30 joints made on site.

Test "dummy" joints shall be made for each pipe diameter specified, prior to commencement on site using the certified welder and approved welding equipment to be used on the contract. Test joints shall be tested in accordance with Appendix B and C of WIS 4-32-08 for butt fusion welds and electrofusion welds respectively. The Contractor shall be required to liaise with any approved Engineering Laboratory staff during the taking of test samples and the performing of site audit checks on the Contractor's equipment to the standards prescribed in WIS 4-32-16 and Volume IP6 – Site Audit Template. Site Audits to review welding procedures in accordance with the specification will be carried out by approved Laboratory staff as required by the Employers Representative.

For the purpose of carrying out such tests the Employer's Representative shall have full authority to have the samples taken, either at the manufacturer's factory or from consignments at the Works, and to submit the same to an approved Engineering Laboratory chosen by him for testing. The Contractor's rates shall allow for the construction and provision of all test joints required and samples and the associated reinstatement for the destructive testing as deemed necessary by the Employers Representative.

Furthermore, the Employer's Representative shall have the right to reject any material as a result of such tests, notwithstanding that the manufacturer's certificates may have shown the materials to be satisfactory. Should the test joints or materials be found to be deficient or rejected the Contractor will complete the works in question again without any entitlement to compensation events, i.e. there will no adjustments to the Contract Sum.

Quality assurance requirements, controls, calibration and records shall be in accordance with WIS 4-32-08.

Where pipe moling or other forms of trenchless insertion of pipelines is used the force applied during the pulling operation must not exceed the values given in the table below.

The Contractor may be required to prove to the satisfaction of the Employer's Representative that the allowable forces listed below are not exceeded.

Pipe Size	Maximum Acceptable Pulling Force (tonne)
90 SDR 11	1.98
90 SDR 17	1.23
125 SDR 11	3.82
125 SDR 17	2.38
180 SDR 11	7.91
180 SDR 17	4.92

Table 8.5: Allowable Forces

Jointing of pipes shall only be carried out by operatives who are certified competent to do so by an approved training provider. Supervising staff must also be appropriately trained.

All joints shall be made strictly in accordance with the manufacturer's instructions. The **Contractor** shall make use of the technical advisory services offered by the manufacturers for instructing pipe jointers in the method of assembly of joints. Before making any joints, all jointing surfaces shall be thoroughly cleaned and dried and maintained in such condition until the joints have been completely made or assembled.

The **Contractor** shall externally debead butt-fusion joints made by him, as directed by the **Employer's Representative**, label the bead to identify the joint from which the bead was taken and hand the bead to the **Employer's Representative** for filing with the print out of the welding machine output applicable to that joint.

Evidence of calibration of the welding equipment shall be provided and maintained throughout the contract. Calibration shall be carried out at least every 12 months. Printouts or electronic format performance data from the machine shall be retained on a daily basis and presented in the next progress report.

Each day prior to the commencement of butt fusion jointing of PE pipes, or after a period of inactivity from welding, or when changing the diameter or SDR of pipes being welded, two 'dummy' welds shall be made to ensure that the portion of the plate to be used for productive welding is free from dust.

7.11 Flanged Joints

Flanges for pipes and pipeline fittings shall, unless otherwise specified in Section 1, comply with BS EN 1092 Part 1 for 16 bar nominal pressure rating.

Flanges shall be properly aligned before any bolts are tightened. Jointing compounds shall not be used when making flanged joints, except that, to facilitate the making of vertical joints, gaskets may be secured temporarily to one flange face by a minimum quantity of clear rubber solution. Both threads shall be treated with graphite paste and the nuts tightened evenly in diametrically opposite pairs.

7.12 Gaskets For Flanged Joints

Gaskets for flanged pipe joints shall be of the inside bolt circle type. The dimensions of gaskets shall comply with IS EN 1514-1. Gaskets shall be manufactured from material complying with the provisions of BS EN 681. For potable water, gaskets shall be Type WA with a hardness range of 76-84. Gaskets shall be suitable for the pressure rating of the flanged pipe. Any special requirements for the type of flange gasket are specified in Section 1.

7.13 Cutting Pipes

Pipes shall be cut by a method which provides a clean square profile, without splitting or fracturing the pipe wall, and which causes minimum damage to any protective coating. Where necessary, the cut ends of pipes shall be formed to the tapers and chamfers suitable for the type of joint to be used and any protective coatings shall be made good and the ends sealed.

Where ductile pipes are to be cut to form non-standard lengths, the Contractor shall comply with the Manufacturer's recommendations in respect of ovality correction and tolerances to the cut spigot end.

Where concrete pipes are cut, any exposed reinforcement shall be sealed with an epoxy resin mortar.

Pre-stressed concrete pipes shall not be cut on site.

The Manufacturer's Guidelines on Health and Safety shall be strictly adhered to in the cutting of Asbestos Cement Pipes or any other type of pipe. The Contractor will be required to prepare a method statement which should cover all aspects of the work, including safe removal and subsequent disposal of sections of AC pipe under license or permit to a licensed waste facility, specifically equipped for handling asbestos waste. There shall be strict adherence to any instructions given by a Local Authority or permit holder regarding the packaging of asbestos waste for removal. The method statement shall clearly detail the Contractor's proposals for executing the works in a manner that will minimise the risk of exposure to asbestos dust to his operatives, the general public, water consumers and those engaged in maintenance works in the future.

It is the responsibility of the Contractor to ensure that all requirements under relevant Health and Safety legislation are adhered to, with particular attention being drawn to requirements under SI No. 386 of 2006 Safety, Health and Welfare at Work (Exposure to Asbestos) Regulations 2006 and under SI No. 589 of 2010 Safety, Health and Welfare at Work (Exposure to Asbestos) (Amendment) Regulations 2010.

The method statement shall include the details as set out in Schedule 3 of SI No. 386 of 2006 Safety, Health and Welfare at Work (Exposure to Asbestos) Regulations 2006. The Contractor shall submit the method statement to the Health and Safety Authority (HSA) so that it is received not less than 14 days before commencing the activity. A copy of this notification is to be forwarded to the Client's Representative.

7.14 Pipe Bedding

Granular bedding for pipes shall be constructed by spreading and compacting Type "A" granular material over the full width of the pipe trench.

Each pipe shall be set to the proper line and gradient. Any adjustment should be carried out such that the pipes finally rest evenly on the adjusted bedding throughout the length of their barrels.

The minimum thickness of granular material below the barrel of the pipe shall be:

- 200mm for pipes up to 450mm diameter
- 300mm for pipes from 500mm diameter upwards
- In rock or mixed soils containing rock bands, boulders or other hard spots the thickness of granular material shall be increased by 100mm

Type "A" granular material shall be placed by hand in the excavation below the level of the pipe barrel and shall be tamped and rammed by hand in layers not exceeding 150mm thick before compaction to provide a dense well compacted bed free from soft spots throughout the length of the pipeline between joint and sling holes.

Where socketed or sleeve jointed pipes are specified the bed shall be cut away and removed at each socket or sleeve to give a clearance of at least 50mm or 100mm for trenches in material designated as Hard Material.

7.15 Granular Pipe Surround

After the pipes have been properly bedded and tested Type "A" granular material shall be carefully placed into the spaces between the pipe and the sides of the trench to the level of half pipe. The Type "A" material shall be thoroughly packed and rammed by careful hand tamping in layers not exceeding 150mm thick before compaction. The placing and the tamping of the material shall proceed equally on both sides of the pipe.

Granular material Type "A" shall be placed and compacted as pipe surround over the full width of the trench in layers not exceeding 150mm before compaction to a minimum finished thickness of 300mm above the crown of the pipes.

Where practical, this shall be done in sequence with the removal of the trench supports.

7.16 Pipe Surround With Type "B" Material

Type "B" fill material shall, where specified, (in fields only) be placed and compacted over the full width of the trench, in layers not exceeding 150mm before compaction to a minimum finished thickness of 300mm above the crown of the pipes.

7.17 Type "A" Granular Material

Granular material Type "A" for bedding, haunch and surrounds to pipes shall be a free draining material consisting of aggregates from natural sources complying with the relevant provision of IS EN 12620:2002.

Type "A" Granular Material shall have a Compaction Fraction Value not exceeding 0.15 and shall consist of an aggregate with a size and grading as shown on the following Table:

Granular Material Type "A"		
Nominal Bore of Pipe (mm)	Aggregate Size (mm)	
	Single Size	Graded
100	10	--
150	10 or 14	14 to 5
225 – 300	10, 14 or 20	14 to 5 or 20 to 5
375 – 525	14 – 20	14 to 5 or 20 to 5
Exceeding 525	14, 20 or 40	14 to 5 or 20 to 5 or 40 to 5

Table 8.6: Granular Material Type "A"

Where PVC-U pipes are used the recommendations of the particular Manufacturers given in writing shall, subject to the Employer's Representative's approval, be the governing factor in the choice of bed and surround material.

Where PVC-A pipes are used the recommendations of the particular Manufacturers given in writing shall, subject to the Employer's Representative's approval, be the governing factor in the choice of bed and surround material. In general, for PVC-A pipes granular material for the pipe bed should be nominal size single 10mm or 5 to 10mm graded.

Pipe bedding and fill material to concrete pipes shall not contain more than 0.3 per cent sulphate expressed as sulphur trioxide.

7.18 SELECTED BACKFILL MATERIAL TYPE "B"

Selected backfill Type "B" whether selected from locally excavated material or imported shall consist of uniform readily compatible material free from vegetable matter, building rubbish and frozen material or

materials susceptible to spontaneous combustion. It shall exclude clay of liquid limit greater than 80 and/or plastic limit greater than 55, materials of excessively high moisture content, clay lumps, retained on a 75mm sieve and stones retained on a 37.5mm sieve.

7.19 **TESTING OF PIPE BEDDING AND SURROUND MATERIAL**

For testing pipe bedding and surround material, a representative sample of about 40kg. shall be heaped onto a clean surface and quartered to obtain approximately 10kg. The moisture content of the sample should not differ materially from that of the main body of material, at the time of use in the trench.

A 150mm internal diameter open ended cylinder, 250mm high, shall be placed on a firm flat surface and loosely filled, without tamping, from the 10kg sample. Any surplus material shall be struck off level with the top of the cylinder. The area around the filled cylinder shall be cleared of all surplus material and the cylinder then filled clear of its contents and placed alongside the material.

Approximately one quarter of the material shall then be placed into the cylinder and compacted by tamping vigorously with a 40mm diameter metal rammer weighing about 1kg. until no further compaction can be obtained. This operation shall then be repeated for each of the remaining quarters, tamping the final surface as level as possible.

The distance from the top of the cylinder to the surface of the final layer shall then be measured and this value, divided by the height of the cylinder, shall be taken as the Compaction Fraction.

The Compaction Fraction (C.F.) Value and Maximum Particle Size shall be in accordance with the Table as follows:

Requirements for Pipe Bedding Materials				
Pipe Nominal Size (DN)	Max. Particle Size Mm	Class of Bedding (see notes)	Suitable Materials	
			Either Aggregate to IS EN 12620	Or having a CF value
100	10	S	10mm nominal single size	0.25 max
150	15	S	10 or 14mm nominal single size or 14 to 5mm graded	0.15 max
225 to 525	20	S	10, 14 or 20mm nominal single size or 14 to 5 graded or 20 to 5 graded	0.15 max
Over 525	40	S	10, 14, 20 or 40mm nominal single size crushed rock or 14 to 5 graded or 20 to 5 graded or 40 to 5 graded	0.15 max

Table 8.7: Requirements for Pipe Bedding Materials

NOTES:

- Class S bedding is 360 degree granular bed and surround (refer to Clauses 8.16 & 8.18 above).
- The greater the CF value of granular bedding materials the greater care in compaction is required.
- In wet soils the migration of fine soil particles with ground water into the voids of the bedding may be minimised by surrounding the granular material with filter fabric.

Extract from "Simplified Tables of External Loads on Buried Pipelines" by TRL HMSO.

7.20 **Concrete Protection To Pipes**

Pipes to be bedded on or cradled with concrete shall be supported on precast concrete setting blocks, the top face of each block being covered with two layers of compressible packing in accordance with Clause 8.21. Concrete provided as a protection to pipes shall be grade C20/25 placed to the required depth in one operation. The concrete protection shall be interrupted over its full cross section at intervals not exceeding

8 metres by a shaped compressible filler in accordance with Clause 8.21. Where pipes with flexible joints are used the concrete protection shall be interrupted to coincide with the pipe joints.

Rapid hardening cement shall not be used in concrete for the protection of plastic pipes. Plastic pipes are to be wrapped with a layer of plastic sheeting complying with WIS 4-08-02 (Specification for Bedding and Sidefill Materials for Buried Pipes) before being surrounded by concrete.

No back filling of the trench shall be carried out until the concrete has reached a cube strength of 15 Newtons per square millimetre.

NOTE: Concrete Specification for use in aggressive soils.

Concreting of bedding, haunching, arch or surrounding shall not be carried out until the pipes have been jointed and inspected. The concrete shall be tamped or vibrated into place under the pipe and the concrete shall be in full contact with the underside of the barrel of the pipe throughout its length. The concrete shall be homogenous mass. There shall be no horizontal construction joint in the concrete below the level of the half pipe.

7.21 Compressible Filler And Packing For Pipelines

Compressible filler for interrupting concrete protection to pipelines shall consist of bitumen impregnated insulating board to BS EN 120 and BS EN 317. The thickness of compressible filler shall be as follows:

Compressible and Packing for Pipelines	
Nominal Bore of Pipe (mm)	Thickness of Compressible Filler (mm)
Less than 450	18
450 – 1200	36
Exceeding 1200	54

Table 8.8: Compressible and Packing for Pipelines

Compressible packing for use between pipes and precast concrete setting blocks shall consist of bitumen damp proof sheeting complying with BS 743, Type G.

Bituminous materials shall not be put into contact with plastic pipes.

7.22 Precast Concrete Setting Blocks For Pipes

Precast setting blocks for pipes shall have rectangular faces, with sufficient plan area to prevent punching of the blinding concrete or Final Surface and to provide an adequate seating for the pipes. They shall be manufactured from Grade C16/20 concrete using the same type of cement as in the adjacent concrete bed, and be cast in an approved mould.

Blocks shall not be used until they have achieved a cube strength of 13.5 N/Sq.mm.

7.23 Clay Puddle

Clay puddle shall be impervious to water, and be free from sand, grit, stones and other deleterious matter.

The clay on being dug shall be exposed to the air for at least 24 hours and thereafter shall be worked with water into a consistency suitable for punning. A roll of clay 300mm long and 40mm in diameter shall support its own weight when suspended from one end.

7.24 Depth Of Cover On Watermains

The minimum depth of the cover on watermains measured from the finished ground surface to the top of the pipe barrel shall be as follows:

Minimum Depth of Watermains	
Nominal Diameter	Depth of cover over barrel of pipe
250mm or less	900mm

300mm to 400mm	1050mm
450mm to 500mm	1200mm
600mm to 900mm	1300mm
1000mm to 1500mm	1500mm

Table 8.9: Minimum Depth of Watermains

Where pipes are laid in footpaths or road margins whose surfaces are higher than the adjacent road, the cover is to be measured from road level.

Where the specified cover cannot be achieved owing to ground conditions encountered, the works specified in Section 1 or shown on the Contract Drawings shall be carried out as directed by the Employers Representative. In any event the Contractor shall accept the risk for the ground conditions encountered and the Contract Sum will not be adjusted owing to the installation of, or connections to, numerous smaller diameter watermains over bridges or culverts in order to achieve the hydraulic pipe capacity as outlined in the Works Requirements.

7.25 Trench Widths – Watermains

Trenches for watermains are to be excavated to widths which fall within the limits shown on the following Table:

Trench Widths – Watermains			
Nominal Internal Dia	Minimum width of trench (mm)	Maximum width of trench permitted (mm)	Nominal Width of Trench (for measurement purposes)
Up to 150mm	450mm	Not Specified	450mm
175mm to 300mm	Nominal Dia. Plus 300mm	Nominal Dia. Plus 400mm	Nominal Dia. Plus 350mm
350mm to 400mm	Nominal Dia. Plus 400mm	Nominal Dia. Plus 500mm	Nominal Dia. Plus 450mm
450mm to 900mm	Nominal Dia. Plus 500mm	Nominal dia. Plus 600mm	Nominal Dia. Plus 550mm
1000mm to 1500mm	Nominal Dia. Plus 900mm	Nominal Dia. Plus 1100mm	Nominal Dia. Plus 1000mm

Table 8.10: Trench Widths - Watermains

Trenches are to have the minimum width specified for their full depth. The maximum width permissible is to be measured between undisturbed sides at a level 300mm above the crown of the pipe, and extra width above this level will not contravene this Specification.

If the Contractor finds it convenient or necessary to excavate trenches to greater widths from a point 300mm over the crown of the pipe, permission to enable him to do so will not be unreasonably withheld, but no payment will be made for an excavation wider than those herein specified, and for any extra material for bedding or surround and no temporary or permanent restorations will be paid for beyond the maximum width of trench hereinbefore specified plus 300mm on either side to allow for breaking surface and later knitting in.

7.26 Trench Widths – Sewers And Storm Water Pipes

From the bottom of the trench to a level of 300mm above the crown of the pipe, trench widths shall not be less than the minimum nor greater than the maximum figures shown in the Table below.

The minimum width is that width between the faces of the soil required to ensure the correct placing and compaction of bedding materials equally on either side of the pipe. All sheeting and supports are to be outside this width. The maximum width is that width between the faces of the soil which has been used in the structural design of the pipeline and it includes an allowance for sheeting and tolerance.

Trench Widths		
Nominal Pipe Diameter mm	Minimum Trench Width mm	Maximum Trench Width mm
100	430	630
150	490	690
225	580	780
300	680	880
375	950	1150
450	1030	1230
525	1120	1320
600	1240	1440
675	1330	1530
750	1400	1600
900	1920	2120
1050	2100	2300
1200	2225	2600
1350	2400	2800
1500	2500	3000
1650	2600	3200
1800	2800	3400

Table 8.11: Trench Widths

If the Contractor finds it convenient or necessary to excavate trenches to greater widths from a point 300mm over the crown of the pipe, permission to enable him to do so will not be unreasonably withheld, but no payment will be made for any excavation wider than those herein specified, and for any extra material for bedding or surround and no temporary or permanent restorations will be paid for beyond the maximum width of trench hereinbefore specified plus 300mm on either side to allow for breaking surface and later knitting in.

7.27 Thrust Blocks

Except where welded steel pipelines, welded polyethylene pipelines or self-anchoring joints are used thrust from bends and branches in pressure pipelines shall be resisted by concrete thrust blocks cast in contact with undisturbed ground. Any additional excavation required to accommodate thrust blocks shall be carried out after the bend or branch is in position and the thrust face shall be trimmed back to remove all loose or weathered material immediately prior to concreting. Thrust blocks shall be allowed to develop adequate strength before any internal pressure is applied to the pipeline. Rapid hardening cement shall not be used in concrete for thrust blocks to plastic pipes. Plastic pipes shall be wrapped with a layer of plastic sheeting complying with WIS 4-08-02 before being surrounded by concrete.

All pressure pipelines, where the pressure is to be resisted by concrete thrust blocks, are to be securely anchored at tees, dead ends, bends, tapers, sluice valves and in all locations where movement due to thrust arising from internal pressure is likely to occur. The thrust blocks shall be adequate to resist all such thrust arising during the normal use of the pipeline and during testing. The anchor blocks are to be blocks of plain or reinforced concrete Grade C16/20 (20mm) in accordance with the details specified in Section 1 and shown on the Drawings.

The thrust block face shall be set against undisturbed soil. The height, (h), of the thrust block shall be equal to or less than half the total depth to the bottom of the block, (Ht), but not less than the pipe diameter. The height, (h), of the thrust block shall be such that the block width (b) varies between one and two times the height (h). The thrust block dimensions referred to above are shown on the Drawings.

7.28 Surface Boxes and Guards

Small and large surface boxes shall comply with the relevant provisions of BS 5834: Part 2 and 3, respectively, or WIS 4-37-01.

If hinged lids are provided the hinge pins shall be of a minimal diameter of 8mm and made from stainless steel or copper alloy to prevent corrosion. Other means of retention of surface boxes shall be resistant to corrosion.

Guards and foundation units for underground stop valves shall comply with the relevant provisions of BS 5834: Part 1 or WIS 4-37-01.

Covers for the surface boxes on watermains shall have either the word "WATER", "UISCE" or the letter "W" cast on the top surface in 75mm letters as applicable. Covers for other applications shall similarly be marked: FH (fire hydrant), WO (washout hydrant), SV (sluice valve) and AV (air valve).

Covers and frames to be installed in carriageways or other areas with frequent passage of vehicles shall be to the minimal grade stated in IS EN 124 or Grade A to BS 5834: 1985.

Covers and frames to be installed in all other areas shall be a minimal Grade of B125 to IS EN 124: 1994, or Grade B to BS 5834: 1985.

Precast concrete sections for chambers and base units for buried waterworks apparatus up to and including 600 x 450mm clear opening shall comply with BS 5834: Part 1 and 4. All sections shall be Grade A as defined in that Standard.

Chambers of materials other than precast concrete shall meet the loading requirements in BS 5834: 1985.

In addition to the requirements of the above, domestic water meter boxes shall be of the waterproof type and shall contain an integral shut off valve on the upstream side together with an integrated non-return valve. They shall be suitable for use with concentric type flowmeters. They shall be adjustable for height and slope. They shall comply with requirements of V210 meters or similar approved by the Employers Representative.

Surface boxes and guards providing direct access to areas of potable water shall be Loss Prevention Council (LPC) 5 compliant.

Where the Contractor encounters "old" non domestic meter connections they shall be responsible for logging and storing the old non compatible flowmeter, recording the final read on the meter and liaising with the Local Authority Non Domestic Meter Section to arrange the installation of a new meter.

7.29 Plastic Chambers And Rings

Plastic chambers and rings shall comply with BS 7158.

7.30 Channels And Benching

In general channels in manholes shall be formed by placing half pipe sections at the base of the manholes and to the same gradient as the outgoing sewers. In the case of the standard type manhole on the small diameter sewers the manhole base will be constructed after laying the sewer line and with the pipe channel directly on the base. In the case of manholes on sewer lines greater than 450mm diameter the manhole base shall first be constructed and the half pipe sections will then be laid to correct level and gradient and supported off the base with suitable concrete support blocks and the channel shall be firmly bedded in concrete along its length when forming the benching. The Contractor shall submit details on his proposed methods of construction of manholes to the Employer's Representative.

Benching shall be neatly keyed to the half pipe sections and shall rise vertically for a distance of 150mm above the crown of the outgoing sewer. From this point the benching shall slope upwards to the walls of the manholes at an even gradient of 1 in 20. The vertical and sloping portions of the benchings shall meet in a sharp curve with a radius as shown on the Drawings for the different manhole size. Benching shall be rendered in 2:1 sand – cement mortar with a smooth trowelled finish. The rendering shall have a minimum thickness of 25mm and the surface shall be lightly punned by wooden beaters and floated to true planes throughout and thoroughly worked and polished with plasterers irons.

Concrete used to form benchings shall be Grade C20/25 and with a minimum cement content of 325 kg/cu.m and placed so as to give a smooth uniform finish.

In the cases where there is a change in pipe diameter it will not be possible to use half pipe sections to form the channel inverts. In the case of standard type manholes the benching shall first be roughly formed and then rendered with a sand/cement mortar. In the case of manholes on larger diameter pipelines, that is above 450mm diameter, the benching shall be constructed by using suitable formwork and finished to give a Class F3 finish.

Details for changes in pipe diameter and for lateral sewers of a small diameter are shown on the Drawings. In general the crowns of all incoming pipes shall be at the same level as the crown of the outgoing pipe. This shall be achieved by having a steeper gradient of the channel invert across the manhole or by having a step in invert levels or a combination of both. If there is a difference in levels between the invert and the incoming and outgoing pipes greater than 600mm a drop manhole will be required. Such drop manholes are detailed in the Drawings.

Where possible, main channel inverts for pipes up to and including 300mm diameter shall be pre-cast concrete channels or where the sewer is constructed of steel or ductile iron pipes, the channels may be of the same material.

Branch bends up to and including 150mm diameter shall be half section curved in the direction of flow and set to deliver over the main channel invert. Branch bends over 150mm diameter shall be curved in the direction of flow and shall be formed in 2:1 sand-cement mortar with a smooth trowelled finish. Spaces between branch bends shall be completely filled with concrete and the faces above the main and branch channel inverts shall be trowelled smooth.

7.31 Watertightness Of Manholes And Chambers

Manholes and chambers shall be substantially watertight, with no discernible flow of water penetrating the works.

Manholes and access chambers shall be subject to tests similar to those specified for water retaining structures.

7.32 Pipes And Joints Adjacent To Structures

Except where the construction is by tunnelling, heading or pipe-jacking, a flexible joint shall be provided as close as is feasible to the outside face of any structure into which the pipe is built, compatible with the satisfactory completion and subsequent movement of the joint.

The length of the next pipe (rocker pipe) away from the structure should not exceed 0.6 metres for pipes up to 600mm nominal bore, 1 metre for pipes up to 750mm nominal bore and 1.25 metre for pipes greater than 750mm nominal bore except where otherwise shown on the Drawings.

A pipeline may, where practicable, be laid through a manhole and the crown broken out to the half diameter, provided flexible joints are situated on each side, no further than 600mm from the inner face of the manhole wall, and that adjacent pipes comply with paragraph 2 of this Clause.

Pipes shall be built in monolithically with the manhole and made fully watertight. A rocker pipe shall be provided immediately after the pipes in and out of the manholes.

Where Ductile Iron pipes are built into manholes or chambers the pipes in and out of the manholes shall be as short as practicable and shall consist of double spigot pipe with puddle flange or flange and spigot pipe with puddle flange. A double spigot rocker pipe and two couplings shall be provided immediately after the double spigot pipe with puddle flange or flange and spigot pipe with puddle flange in and out of the manhole. In general pipes built into structures shall be installed in accordance with manufacturer's requirements.

7.33 Setting Manhole Covers And Frames

Manhole frames shall be set to the required level on blockwork at least 100mm high and not more than 300mm high and 225mm wide. The frames shall be set to level, bedded and haunched over the base and

sides of the frame in Grade C16/20 concrete. In heavily trafficked locations a special proprietary type mortar shall be used. When fixed in position the cover shall be flush with the surface of the restored road and if on completion of the work any manhole cover is found either projected or depressed beyond the level of the road surface it will be incumbent on the Contractor to take out the cover and frame and re-set them at proper level.

7.34 Connections To Sewers And Manholes

Transfer of Existing Connections to new Sewers shall be carried out using “Y” Junctions or “T” Junctions where appropriate and fixed in position as the work proceeds. Connections to existing sewers shall also be carried out using “Y” Junctions or “T” Junctions where appropriate.

Saddle connections to existing sewers shall only be allowed when the internal diameter of the major pipe is at least 150mm greater than the internal diameter of the branch pipe.

The ends of connections and pipes not required for immediate use shall be closed with purpose made stoppers or discs. The position of all junctions shall be recorded by the Contractor by measurement from the access manhole / chamber immediately downstream and notified to the Employer's Representative before backfilling is commenced.

Pipe saddles for concrete sewers, where approved for use by the Employer's representative, shall be bedded in Class M1 mortar and a mortar fillet formed to give a cover of at least 50mm to the base of the saddle. Pipe saddles for Ductile Iron Sewers shall be applied and fixed in accordance with the Manufacturer's instructions. Pipe saddles for uPVC pipes, where approved for use by the Employer's Representative, shall be purpose made from uPVC and shall either be of a mechanical clip-on type or shall be fixed with an appropriate solvent cement. Pipe saddle connections will only be allowed on the approval of the Employer's Representative.

Where a connection without a saddle is to be made to an existing sewer, the pipes shall be splay cut to give an oblique junction, so that the discharge is in the direction of flow in the main sewer. The connecting pipe shall be of such a length that the pipe rests on the outside barrel of the main sewer with no projection inside the main sewer. The pipe joint shall then be pointed in mortar externally and internally where practicable. This type of connection will only be allowed on the approval of the Employer's Representative.

Where interconnection is required between an existing manhole and a proposed manhole the existing manhole shall be reconstructed from base to cover in accordance with the relevant Clauses of this Section 8 unless the base of the existing manhole has provision made for the connection in the form of appropriately sized channels and properly formed benching.

7.35 Junctions And Laterals On Sewers

Junctions and laterals shall be effectively sealed with an end cap, the location of which shall be positively indicated.

7.36 Laying PVC-U Pipes

The trenches in which PVC-U pipes are to be laid shall be excavated to such a depth to allow the pipes to be laid on a prepared underbed. The trench bottom should be carefully examined for the presence of hard objects such as stones, rock projections, or tree roots, and if any such objects are present, they should be removed. In uniform, relatively soft, fine grained soil, free of such hard objects, the underbed when lightly compacted should have a thickness of not less than 100mm or one quarter of the pipe diameter, whichever is greater.

Where the trench is through rock or through materials which show the recurrence of the above mentioned hard objects, allowance should be made in the cutting of the trench for an additional thickness of underbed of at least 50mm. The prepared underbed should consist of a fine grained material in size. An excess of fine particles which might impede drainage or compaction should be avoided. In all cases the underbed should be to the correct gradient and should provide uniform support to the pipe over its full

length. Special care should be taken when handling and laying PVC-U pipes at temperatures below 10°C, to avoid impact damage. Pipes should not be laid, cut to length, or tapped when the temperature is 0°C or below.

7.36.1 Jointing PVC-U Pipes

Joints in PVC-U pipes shall be made using fixed seal couplers. Only lubricants approved by the pipe manufacturers should be used, and on no account should oils or grease be used as they may attack the seals. The couplers and pipe ends should be clean when a joint is being made and no grit or dirt should be trapped behind the sealing rings. The pipe should be pushed fully home in the coupler as indicated by the homemark on the pipe end, which should be marked on the pipe and before the joint is made.

7.36.2 Fittings and Specials on PVC-U Pipes

All tee-pieces, sluice valves, meters, and other fittings (with the exception of bends where they are available in PVC-U) should be flanged Cast Iron fittings with suitable flanged adapters (which should also have fixed seals) to connect them to the main pipeline. If tee pieces are available with fixed seals suitable for connection to PVC-U pipes, these may be used also. The conditions mentioned above for jointing PVC-U pipes also apply to the connections of Cast Iron fittings to PVC-U pipes.

All junctions between cast iron and ductile iron pipes and fittings and hard PVC pipes are to be made with special cast iron adapters or couplers all in accordance with the Manufacturer's instructions. All of the instructions contained in the Industrial Research "Recommendations for the Handling and Installation of Un-Plasticized PVC Pipe" shall be regarded as minimum requirements for the purpose of the Specification.

7.36.3 Widths of Trenches for PVC-U Pipes

When laying PVC-U pipes the trenches are to be open to a width of the pipe outside diameter plus 300mm.

7.37 Laying High Density Polyethylene Pipes (Hdpe)

High Density Polyethylene Pipes are to be laid on a smooth bed. When laying through rock the trench is to be excavated to a depth of an extra 100mm and a level underbed of sand gravel or soil provided.

7.37.1 Jointing High Density Polyethylene Pipes

High Density Polyethylene Pipes are to be jointed by butt fusion welding, electrofusion welding, mechanical compression fittings or push fast fittings all in accordance with the Manufacturer's instructions and/or as specified in Volume A1 of this specification. The joints to be used must have the prior written approval of the Employer's Representative.

Bends of 45 Deg. or sharper are to be anchored by blocks of Grade C12/15 concrete. The concrete block is to be inserted under and around the pipe and between it and the side of the trench on the outside of the bend. The bends shall be wrapped in approved heavy gauge visqueen or other suitable wrapping prior to the pouring of the concrete. All junctions between cast iron or ductile iron pipes and fittings and High Density Polyethylene pipes are to be made with special cast iron adapters or couplers all in accordance with the Manufacturer's instructions.

7.37.2 Fittings on High Density Polyethylene Pipelines

All tee-pieces, sluice valves, meters and other fittings on High Density Polyethylene Pipelines are to be flanged C.I. fittings with suitable flanged adapters to connect them to the main pipeline. All fittings are to be supported on base pads of concrete Grade C12/15.

7.38 Laying High Performance Polyethylene Pipes (Hppe)

The trenches in which HPPE pipes are to be laid shall be excavated generally to the depths specified already and depending on pipe diameters all so as to allow the pipes to be laid on the prepared underbed already described for other pipe systems. Procedures similar to those specified for HDPE and PVC-U pipes shall be carefully followed for trench excavation and preparation.

7.38.1 Jointing HPPE Pipes

Pipes shall be Butt Fusion jointed as already described in Clause 8.31.1 above or Electrofusion jointed (IS EN 12201 Part 3 and WIS 4-32-08).

7.38.2 Fittings and Specials on HPPE Pipes

Jointing of fittings to HPPE pipes shall be either by electrofusion or butt fusion methods where these fittings are available from the manufacturer. Such fittings would generally include couplers, reducers, tapping tees, bends, tees and end caps. Sluice valves and meters should be flanged C.I. fittings with suitable flanged adaptors, pupped flanges or similar (which should also have fixed seals) to connect them to the main pipeline.

7.38.3 Widths of Trenches for HPPE Pipes

Trenches for HPPE Pipes are to be of the widths already specified for Watermains generally.

7.39 Service Fittings

Pressure tappings to water mains shall, unless otherwise specified, be carried out by means of a right angled screw down ferrule of non-ferrous material in combination with a saddle piece. The saddle and ferrule shall be set on the main so that the service pipe leads off in line with the main before curving around to its intended course.

Service connections to hard PVC, High Density Polyethylene Pipe and High Performance Polyethylene Pipe shall be made by using the saddles and ferrules recommended by the Pipe Manufacturers. Where PVC saddles are used the fittings shall consist of the combined PVC Saddle and Self Tapping Ferrule.

Tappings are to be made in conjunction with all electromagnetic flowmeter installations, in association with contract drawing. The tappings will be transferred in a suitable duct to the kiosk and shall be connected to a ¼ turn valve for isolation purposes and a BSP male mechanical connection.

7.40 Service Pipes

Service Pipes where required are to be laid with a minimum cover of 600mm. They are to be laid on a smooth bed and to be covered to a depth of at least 100mm with fine material.

Polyethylene Pipes shall comply with I.S. EN 12201 for the transportation of potable water under pressure.

Malleable Copper pipes where approved for use shall conform to IS EN 1057: 1996 and fittings for use in conjunction with these shall conform to IS EN 1254 Part 1 (capillary) or Part 2 Type B (manipulative).

7.41 Closure Units Of Watermains

- Where pipes of non-standard lengths are required to close gaps in watermains, these shall be provided and arranged as recommended by the Pipe Manufacturers.

- On Ductile Iron Watermains the closure sets are to consist of three pieces, as provided by the Manufacturer, the middle piece being plain ended and jointed with Couplings. After the pipeline has been tested, the couplings are to be wrapped and protected externally.
- Closure units will be required at the approaches to some of the valves and fittings, and possibly at the approaches to Valve or Control Houses / Chambers, where in most cases the position can be varied only slightly within the boundaries of the lands acquired. There is, however, sufficient flexibility available in the location of the Valve Houses / Chambers both in the longitudinal direction of the pipeline and at right angles to it to enable the houses / chambers to be so located that the only non-standard lengths required in most cases will be half lengths.

Closure units will be required at some bends, at approaches to some river crossings, and at other locations including sections where pipe-laying gangs meet. This latter point should be carefully chosen beforehand in order to avoid haphazard or awkward Closure Units.

The Contractor is to include, for normal pipelaying, for the provision of all closure units as and where required.

7.42 Indicator Plates

All sluice valves, scour valves, air valves and hydrants are to have indicator plates fixed overground on a nearby wall or concrete post. The indicator plates for sluice valves, scour valves and air valves are to be cast iron plates 225mm x 150mm in size and with the letters S.V.; Sc.V.; or A.V. as appropriate raised thereon. The letters are to be painted black and the background white. The Sluice Valve indicator shall also show by means of an arrow the direction of opening. Indicator plates for hydrants are to be of a type and pattern approved by the Employer's Representative and the colour for fire hydrant plates shall be in accordance with BS 3251 (black letters on a yellow background). They are to incorporate a panel showing in each case in metric units, the information specified in BS 750. The figures in the panels are to be removable and are to be finally fixed in position when the plate is being installed. Where plates are mounted on concrete pillars, these are to be 300mm wide x 100mm deep x 600mm high over ground surface and not less than 1300mm overall length.

7.43 Marker Tape

A Blue Colour Detectable marker tape shall be used over Watermains while a Brown Colour Detectable marker tape shall be used for foul Sewers and White / Blue shall be used for Surface Water Pipelines.

Marker tape for buried cables shall be yellow PVC or polyethylene mesh or ribbon at least 150mm wide printed with the words "ELECTRICAL CABLE" in bold capital letters throughout its length and at intervals not exceeding 700mm.

Other marker tape shall be as follows:

Telecommunication	Green
Gas	Red
Cable TV	Red, Blue, Green, Chevron
Others	Black / White

Where marker tape is removed during excavation from existing services it shall be replaced during the backfilling process.

7.44 Ventilating Columns

Ventilating columns shall be of steel 150mm in diameter and standing 7.60m high overground with cast iron ornamental bases 1,200mm high. The steel shaft shall consist of galvanised steel tube not less than 5mm thick terminating at the top with a copper wire ball having 10 B.W.G. vertical wires, and 14 B.W.G. spirals. The tube shall be painted externally and internally once before erection, internal painting being executed with the aid of long arm brushes or a drag.

The base of the column shall be of heavy cast iron. It shall have an air tight door giving access to a chained removable dust box. The whole shall finally be painted with approved bitumastic paint of suitable shade and with two coat work to the satisfaction of the Employer's Representative.

The column shall be buried in the ground to a depth of 800mm and shall be surrounded with a block of concrete 900mm square and 900mm deep with Grade C20/25 concrete. The shaft shall be connected to the sewers and manholes with suitable short lengths of 150mm dia. Concrete or uPVC pipe. After erection of the base the tube shall be set level therein plumbed and grouted.

7.45 Sewer Linings

Sewer linings shall comply with the relevant provisions of the appropriate Water Industry Specification (WIS) as set out in the following Table:

Sewer Linings	
Type	WIS
Glassfibre reinforced cement (GRC)	4-12-04
Precast gunite	4-12-05
Precast and in-situ ferrocement	4-12-06
Polyethylene (PE) pipes (non-pressure applications)	4-32-05
Glassfibre reinforced plastics (GRP)	4-34-02
Cured-in-place pipe (CIPP)	4-34-04
Polyester resin concrete (PRC)	4-34-05

Table 8.12: Sewer Linings

7.46 Testing Of Pvc-U Pressure Pipes

In the case of PVC-U pipes the criteria to be applied in determining the result of a test should be:

No appreciable loss of pressure over a period of 30 minutes.

The maximum allowable leakage from the main, which has been subjected to the test pressure and allowed to stand under pressure for 24 hours, should not exceed 100ml per mm nominal pipe size per km. This is measured by the volume of "make up" water required.

The Working Pressures and the Testing Pressures for the Classes of PVC-U are stated in the following Table:

Testing of PVC-U Pressure Pipes				
Pipe Class	Working Pressure		Test Pressure	
	Metres Head	PSI	Metres Head	PSI
B	60	85	90	123
C	90	123	135	192
D	120	170	180	256

Table 8.13: Testing of PVC-U Pressure Pipes

7.47 Testing Of Ductile Iron Pressure Pipes

The testing of Ductile Iron pressure pipelines shall be carried out in accordance with BS 8010 Part 2 – Code of Practice for "Design, Construction and Installation of Pipelines on Land. Section 2.1 Ductile Iron".

The test pressure for ductile iron pipes, fittings and flanged joints shall not be less than the greater of:

Working pressure + 5 bar

Maximum pressure under surge conditions.

Where fittings have restricted test pressure ratings the test pressure shall not exceed 1.5 x maximum allowable working pressure. Anchor gaskets have a restricted working pressure rating depending on diameter and will be subject to a maximum test pressure of working pressure + 5 bar.

A minimum period of 24 hours shall be allowed between filling the pipeline and applying the test pressure to allow for absorption of water in the cement mortar linings.

The acceptable standard of loss in ductile iron pipelines is 0.02 litres / mm of nominal bore per km per 24 hours per bar pressure.

7.48 Testing Of Polyethylene Pressure Pipes

The testing of polyethylene pressure pipelines shall be carried out in accordance with the procedures in the Water Industry Information and Guidance Note, IGN 4-01-03, 'Pressure Testing of Pressure Pipes and Fittings for Use by Public Water Suppliers'.

7.49 Testing Of Pvc-A Pressure Pipes

The testing procedure for PVC-A pressure pipelines shall be carried out in accordance with the procedures in the Water Industry Information and Guidance Note, IGN 4-01-03, 'Pressure Testing of Pressure Pipes and Fittings for Use by Public Water Suppliers'.

7.50 Cleaning Of Pipelines

On completion of construction, and before any sterilisation of watermains or before any connections are made to sewers internal surfaces of pipelines shall be cleaned thoroughly in such a way as to remove all oil, grit and other deleterious matter without damage or danger to the pipes.

7.51 Precautions Prior To Testing Pipelines

Before testing any pipeline, the Contractor shall ensure that it is anchored adequately and that thrusts from bends, branch outlets or from the pipeline ends are transmitted to solid ground or to a suitable temporary anchorage.

Open ends shall be stopped with plugs, caps or blank flanges properly jointed. The Contractor shall ensure that the pipelines are tested in a safe manner. Testing against closed valves shall not be permitted.

7.52 Notification Of Test

The Contractor shall notify the Employer's Representative at least one clear working day beforehand of his intention to test a section of pipeline.

7.53 Testing Gravity Pipelines

Gravity pipelines laid in open cut shall be tested after they are jointed and before any concreting or backfilling is commenced, other than such as may be necessary for structural stability whilst under test.

The pipelines shall be tested by means of an air or water test or by a visual examination, in lengths determined by the course of construction, in accordance with a programme approved by the Employer's Representative. A further test shall be carried out after the backfilling is complete.

In general pipelines of nominal diameter less than 450mm will be tested by means of a Water Test. In the case of larger sewers of nominal diameter 450mm or over or where in inaccessible portions of the works water for testing pipelines cannot be conveniently provided, an air test may on the approval of the Employer's Representative, be substituted for the Water Test.

7.54 Water Test For Gravity Pipelines

The test pressure for gravity pipelines shall be not less than 1.2 metres head of water above the pipe soffit at the highest point and no greater than 6 metres head at the lowest point of the section. Steeply graded pipelines shall be tested in stages in cases where the maximum head, as stated above, would be exceeded if the whole section were tested in one length.

The pipeline shall be filled with water and a minimum period of two hours shall be allowed for absorption, after which water shall be added from a measuring vessel, at intervals of 10 minutes and the quality required to maintain the original water level noted. Unless otherwise specified, the length of pipeline shall be accepted if the quality of water added over a 30 minute period is less than 0.5 litre per lineal metre per metre of nominal bore.

Notwithstanding the satisfactory completion of the above test, if there is any discernible leakage of water from any pipe or joint, the pipe shall be replaced and/or the joint remade, as appropriate, and the test repeated until leakage is stopped.

7.55 Air Test For Gravity Pipelines

Gravity pipelines to be air tested shall have air pumped in by suitable means until a pressure of 100mm head of water is indicated in a U-tube connected to the system. The pipelines shall be accepted if the air pressure remains above 95mm head of water after a period of 5 minutes without further pumping following a period for requisite stabilisation. Failure to pass the test shall not preclude acceptance of the pipeline if a successful water test, ordered by the Employer's Representative, can subsequently be carried out in accordance with Clause 8.54 above.

7.56 Inspection Of Gravity Pipelines

CCTV inspections shall comply with the Model Contract Document for Sewer Condition Inspection, published by The Foundation for Water Research.

A CCTV inspection shall be carried out on all gravity sewers and in addition to the CCTV inspection a man-entry visual inspection shall be carried out on sewers of 900mm nominal diameter or over. Where internal inspection of pipelines by closed circuit television is required, the Contractor shall provide all necessary equipment, including suitable covered accommodation for viewing the monitor screen, together with personnel experienced in the operation of the equipment and interpretation of results.

The intensity of illumination within the pipe and the rate of draw of the camera shall be such as to allow a proper examination of the inside of the pipe. Provision shall be made for the movement of the camera to be stopped and its position recorded and for permanent photographs to be taken at any point requested by the Employer's Representative.

For the visual inspection of gravity sewer lines of nominal diameter 900mm or over the Contractor shall provide lighting by means of generator or otherwise. The Contractor shall include for having Photographs taken in the pipelines in conjunction with the visual inspection at the locations required by the Employer's Representative but based on two photographs at intervals of 25 metres. The Contractor shall also provide assistance for the carrying out of such visual inspection.

7.57 Infiltration

Gravity pipelines and manholes shall be tested for infiltration after backfilling. All inlets to the system shall be effectively closed, and any residual flow shall be deemed to be infiltration.

The pipeline, including manholes shall be accepted as satisfactory if the infiltration, including infiltration into manholes, in 30 minutes does not exceed 0.5 litre per linear metre per metre of nominal bore. Notwithstanding the satisfactory completion of the above test, if there is any discernible flow of water entering the pipeline at a point which can be located either by visual or CCTV inspection, the Contractor shall take such measures as are necessary to stop such infiltration.

7.58 Swabbing Of Watermains

On completion of the hydraulic test on watermains, a foam swab shall be passed through the mains for final cleansing sufficient times to achieve clear wash water. The swabs shall be driven by water fed into the main by an approved system of temporary pipework which must incorporate a double check valve to ensure there is no possibility of back siphonage into the existing main.

Swabs for cleaning watermains shall be solid, cylindrical polyurethane foam in accordance with BS EN ISO 845 and BS 3379. Recovery of the swabs shall be witnessed by the Employer's Representative Site Staff.

Swabs have a density of 20 – 25 kg/m³, minimum tensile strength 95 kN/m² and a hardness (at 50% deflection to BS 4443 Parts 1, 2 and 4) of 19 to 23 kg. The diameter of the swab shall be as follows:

- Hard swabs: nominal bore of main.
- Soft swabs for mains less than 200 mm: nominal bore + 50mm.
- Soft swabs for mains greater than 200 mm: nominal bore + 75mm.
- The length of the swab shall be 1.5 times its diameter.

Clear wash water shall be defined as having a turbidity of less than 1 NTU (Nephelometric Turbidity Units).

7.59 Sterilisation Of Watermains

This Clause applies to any works involving the installation of new watermains, the rehabilitation of existing watermains, repairs to, connections to or working on existing watermains. In undertaking any such works the Contractor shall apply the hygiene measures and flush and sterilise watermains in accordance with the relevant measures of the following documents:

- “European Communities (Drinking Water) (No. 2) Regulations, 2007 (S.I. 278 of 2007) A Handbook on Implementation of the Regulations for Water Services Authorities for Public Water Supplies” published by the Environmental Protection Agency in 2010 (ISBN: 978-1-84095-349-7). Section 12.4 New Mains, Repaired Mains and Re-Lined Mains.
- “Principles of Water Supply Hygiene Document” published by Water UK in April 2010 and current Technical Guidance Notes published by Water UK.

The Contractor shall prepare Operating Procedures / Method Statements that set out the measures to be taken which are relevant and specific to the works being undertaken under the Contract.

The Contractor, prior to making connections or executing any works on a watermains or service reservoir that is being used to supply water, shall coordinate the works with the Sanitary Authority / Water Services Authority and shall comply with any procedures of the authority relating to such works.

The Contractor shall thoroughly flush out and sterilise all the watermains in the system, and during the flushing and sterilising any connections which may have been made to the mains shall be closed.

The flushing and sterilising shall continue until the Employer's Representative is satisfied that all foreign matter of deleterious character has been entirely removed from the mains or rendered innocuous.

For sterilisation, liquid chlorine, dry chlorine, or calcium hypochlorite may be used, and the various supply and distribution systems shall be divided into convenient sections and systematically treated with sterilant.

Chlorine shall be injected at such a rate that the residual chlorine available at the discharge point shall be at least 10 parts per million. When such a residual has been recorded the inlet and scour valves shall be closed and the mixture shall be allowed to stand in the mains for at least two hours. The outlet sluice valve or scour valve shall then be opened and the section of main treated shall be thoroughly flushed out before chlorination of the next section is commenced.

7.60 Cleaning Of Structures

On completion of construction and before any sterilisation, internal surfaces of structures designed to retain an aqueous liquid shall be cleaned thoroughly in such a way as to remove all oil, grit and other deleterious matter.

7.61 Disposal Of Water For Cleaning, Testing Or Disinfection

Facilities shall be provided for the removal and disposal of water used for disinfection, swabbing or testing. Discharge to sewers shall not take place without the consent of the Wastewater Treatment Plant Operator. Water used in cleaning, testing or disinfection of structures or pipelines shall be rendered safe

prior to discharge to the environment. Following a water test, pipelines and structures shall be emptied, as far as is practicable.

7.62 Water For Testing And For Construction Purposes

The Contractor shall by whatever means he finds possible, provide for the supply of all water necessary for construction and in testing of the works as well as for headquarters office use and in sanitary accommodation for workpeople where appropriate.

The existing Water Supply Scheme cannot be assumed by the Contractor as a source of water supply for construction and in testing of the works as well as for office use and in sanitary accommodation for workpeople, unless otherwise specified in Section 1.

The Local Authority will however co-operate in supplying water only if at the time of construction or testing it is readily available and surplus to their own requirements. Provided always that the Contractor shall pay all charges levied on him by the Local Authority for the making of tappings, and also that the Contractor shall himself, supply, lay and subsequently remove all requisite piping which shall be approved by the Employer's Representative Site Staff as to quality and suitability of jointing.

Provided also that the Local Authority shall not be bound to afford such a supply of water, if by virtue of such action the efficiency of the general waterworks is in jeopardy, or if it appears to the Employer's Representative Site Staff that the provision of such a supply may interfere with or endanger the power and responsibility of the Local Authority to maintain and fulfil its obligations to supply the surrounding districts with water.

In such circumstances the Contractor would have to make alternative arrangements for water supply for testing purposes.

In locations where water mains are not adjacent to the works the Contractor shall at his own expense independently supply all necessary water for all purposes in connection with the Contract. In so providing his own independent water supply, the Contractor shall not interfere with existing water rights and shall in the event of his abstracting water from any stream, headrace, tailrace, well or pond, save the Council harmless against any claim for loss of water, and from all costs, charges and expenses arising out of or in respect of such claims, real or alleged.

7.63 Opening, Backfilling And Reinstatement Of Trenches

The opening, backfilling and reinstatement of trenches in public roads shall be carried out in accordance with the Guidelines for the Opening, Backfilling and Reinstatement of Openings in Public Roads September 2015 and amendments published by Department of Transport.

Due regard should be given to the HSA publication entitled "A GUIDE TO SAFETY IN EXCAVATIONS" dated January 2007 and the requirements listed therein, which may be downloaded from <http://publications.hsa.ie>.

The Contractor shall agree the precise line of the pipeline with the Road Authority before the commencement of construction.

Existing services exposed during trench excavation shall be wrapped in 12mm neoprene rubber, or similar approved, before backfilling.

The Contractor shall submit to the Local Authority Roads Department As-Constructed drawings detailing the line and depth of the installed pipework and chambers. Details of the dates of excavation / temporary reinstatement and final reinstatement shall be provided by the Contractor to the Local Authority Roads Department including confirmation in writing that the trench reinstatement complies in full with the Guidelines for Opening, Backfilling and Reinstatement of Openings in Public Roads September 2015 and amendments published by Department of Transport.

All material excavated for pipelines in public roads and road margins, with the exception of road surfacing material, which complies with the Specification as being suitable for, re-use, shall be removed to spoil continuously as excavation proceeds.

7.64 Backfilling – General

Backfilling shall, wherever practicable, be undertaken immediately the specified operations (laying, jointing, testing, haunching and surrounding watermain, sewers and other pipelines and final approval of the work as being in compliance with the appropriate sections of the Specification) preceding it, have been completed. Backfilling shall not, however, be commenced until the works to be covered have achieved a strength sufficient to withstand all loading imposed thereon.

7.65 Reinstatement

The Contractor is to temporarily and permanently restore all surfaces, unless otherwise specified in Section 1, and maintain these surfaces for the duration of the Contract and of the period of maintenance.

Temporary reinstatement where specified is defined as the first stage of a two-stage reinstatement procedure where a dense bitumen macadam course is laid over a granular sub-base. The temporary reinstatement must be maintained for a minimum consolidation period of six months, before permanent reinstatement is carried out, and shall seal and maintain the area of backfill and provide a safe and serviceable surface for vehicles and other road users.

Permanent reinstatement where specified is defined as the second stage of a two-stage reinstatement procedure where the temporary reinstatement is removed and the permanent pavement reinstatement is completed. Permanent reinstatement where specified shall be carried out by using materials fully in compliance with the requirements of the Guidelines for the Opening, Backfilling and Reinstatement of Openings in Public Roads September 2015 and amendments published by Department of Transport. Permanent reinstatement shall only be carried out after a minimum consolidation period of six months has elapsed since the temporary reinstatement was placed. Approval to proceed with the permanent reinstatement will be subject to the approval of the Employer's Representative. The Contractor shall maintain accurate records of when the temporary reinstatement was placed on each section of works and shall forward these records to the Employer's Representative.

Prior to the placing of temporary and permanent reinstatement, the Contractor shall saw cut the edges of all existing road surfaces and foundations and shall seal the exposed edges. Any breaking of road surfaces leaving irregular edges will not be permitted.

The width for temporary and permanent reinstatement shall be the maximum width of trench for each pipe size plus 300mm on either side to allow for breaking surface and later knitting in.

If through the improper use of machinery or through carelessness or for any other avoidable cause, the Contractor disturbs a greater width of road than that defined above he shall be responsible for the proper restoration of such extra width at his own expense.

Surface Dressing, to Clause 919 of the TII / NRA Specification for Road Works, shall, unless otherwise specified in Section 1, be an inverted double dressing, as defined in the IAT Guidelines for Surface Dressing in Ireland, with 6mm and 14mm chipping size. The design and application of the surface dressing shall comply with the IAT Guidelines for Surface Dressing in Ireland.

The temporary restoration of surfaces shall be carried out as soon as possible after backfilling and consolidation has been completed but not more than one week from the time when that particular section of trench has been backfilled. When the excavations have been filled and rammed to thorough consolidation as hereinbefore specified to within such distance of the surface as is required for the reinstatement of the surface according to its particular class and after the existing surface on either side of the trench has been saw-cut for future knitting in, Surface Restoration shall be executed as detailed in the Guidelines for Opening, Backfilling and Reinstatement of Openings in Public Roads September 2015 and amendments published by Department of Transport.

7.66 Materials For Backfilling And Reinstatement

Materials for backfilling and reinstatement shall be in accordance with those detailed on the Reinstatement Drawings of the Guidelines for the Opening, Backfilling and Reinstatement of Openings in Public Roads September 2015 and amendments published by Department of Transport.

Compaction of backfill material shall be carried out in accordance with the Guidelines for the Opening, Backfilling and Reinstatement of Openings in Public Roads September 2015 and amendments published by Department of Transport.

7.67 Backfilling Of Trenches In Fields

Excavations in grass verges, medians, fields and lawns, shall be backfilled and reinstated in accordance with standard drawing SD14 of the Guidelines for the Opening, Backfilling and Reinstatement of Openings in Public Roads September 2015 and amendments published by Department of Transport.

7.68 Settlement In Temporary Restoration

Failure to operate and maintain compaction equipment in accordance with manufacturer's schedules and recommended practices results in inadequate compaction with serious implications for the short term performance of individual structural layers and the long term integrity of the entire reinstatement. All compaction equipment covered by this Specification must be frequently checked, adjusted and maintained, as necessary, in accordance with the manufacturer's recommended practices, in order to ensure that the manufacturer's recommended operating frequency is maintained throughout each compaction operation. All compaction equipment covered by this specification must be used in accordance with the manufacturer's recommended operating procedures.

The Contractor shall maintain a constant and careful vigilance over the temporary surfaces constructed by him in accordance with foregoing clauses, and shall be responsible for their appearance during the settlement period.

As and when depressions occur in the temporary restoration these shall be promptly filled by the Contractor at his own expense to a level flush with adjacent surfaces and sealed.

If in the opinion of the Employer's Representative the Contractor fails to make good all such temporary reinstatement without delay the Employer's Representative shall be at liberty to get the work done by other means and to deduct expenses thereof from any monies that are, or may be due to him, or to obtain the said expense from the Contractor or from his sureties.

7.69 Protection Of Restored Surfaces

After road surfaces over trenches have been temporarily restored and until such time as the permanent road restoration is undertaken the Contractor shall provide and maintain suitable fluorescent warning signs for traffic on all road approaches to the work. On each approach road at least two warning signs are to be provided, one close to the work and the other suitably sited approximately 100m away or otherwise as directed or approved. Special speed limits must be enforced on all temporary reinstatement as specified in Section 1.

Where pipelines are in road margins, similar arrangements are to be made and in addition warning signs at intervals of not more than 30m are to be provided on soft shoulders and maintained until consolidation is complete.

Where pipelines are on private property, the Contractor shall provide and maintain sound temporary fences on both sides of the wayleave until restoration of the surfaces over the wayleave area are deemed by the Employer's Representative to be complete. The fences shall be proof against cattle, sheep or other stock or pedestrian as required by the landowner.

Restoration of trenches in fields or gardens will not be deemed complete until the growth of grass is sufficiently sturdy to withstand normal usage of livestock or farm traffic or until four months has elapsed since seeding, whichever is the longer.

Contractors shall also provide fenced access passes across the trench, where required by the landowners for the passage of livestock and other traffic and these passes shall where necessary have suitable temporary paving, which shall be removed by the Contractor before the end of the Contract.

7.70 Quality Control Of Backfill And Reinstatement Materials

Testing of materials used for backfilling and reinstatement shall be carried out in accordance with Section 6.10 of the Guidelines for the Opening, Backfilling and Reinstatement of Openings in Public Roads September 2015 and amendments published by Department of Transport.

7.71 Metal Plates

Metal plates shall be provided with all non-metallic pipelines and ducting at a spacing of 25m intervals and over each connection point not characterised by a junction box / manhole or other visible feature. The plates shall be a minimum of 125mm by 125mm and galvanised. The depth of installation shall be 300mm below the final surface.

8 Roads And Footways

8.1 Footpaths

All unbound granular fill materials to be used under floors, rafts, foundations or other structures in the ground, roads, footpaths or other pavements, shall conform with the requirements of IS EN 13242 and Table E.1 from Annex E of SR21, in addition to any other requirements specified in other sections of this specification. Similarly, all aggregate for use in concrete, for whatever purpose, shall at least comply with these requirements, in addition to all other requirements in this specification.

Only natural crushed rock aggregates shall be used under any concrete structure, including floors, rafts or other foundations, road pavements or footpaths.

Prior to first use from any source, the Contractor shall obtain from the supplier confirmation of the material having been tested from the specific source (including the particular extraction section of the quarry in accordance with the practice recommended in SR21), and provide certification as evidence of such testing confirming that the materials conform to the requirements set out above. The Contractor shall not supply any materials from any different source (or different extraction source from a quarry) unless appropriate testing in accordance with the above requirements has been carried out and certification provided.

For the avoidance of doubt, the above requirements in relation to fill material, shall apply to all fill material directly underneath any of the elements identified, and any fill materials within 500mm to any side of any such elements.

All footpaths to be laid with a minimum cross-fall of 1/40. Where adjacent to roadways this slope shall be towards the roadway. The pathway shall be laid on 75mm hardcore blinded with 50mm of stone of maximum 25mm compacted with a vibrator roller.

Footways should have a sub-base, of minimum thickness 100mm, and should be of in-situ concrete construction. 100mm in depth generally, but increasing to 150mm where there is vehicular access.

An air entraining agent shall be incorporated in the concrete used in the construction of at least the top 50mm of paving to be used as a running surface. The total quality of air in air-entrained concrete for paving shall be 4.5% +/- 1.5% by volume of the mix. Additional admixtures shall not be used in concrete containing an air entraining agent.

The finishes of the concrete path will be a "spike rolled" finish, with bull nosed edges to transverse joints.

All steps and ramps to comply with parts K and M of the Building Regulations. Handrails to be provided to all ramps in accordance with building regulations.

8.2 Concrete kerbs

Where cast in situ concrete kerbs are proposed they shall be either 250mm deep by 150mm thick laid on a 100mm thick x 300mm wide concrete bed and haunch or be designed to sit 50mm on to finished concrete carriageway surface being 175mm thick on top section and 125mm thick on lower section. Concrete throughout shall be Grade C20/25 Concrete with maximum size of aggregate 20mm. Where precast kerbs are used they shall be 250mm x 125mm complying with IS 146 and shall be laid on a 100mm thick by

300mm wide concrete bed and haunch Grade C16/20 concrete. Alternative kerb types at carriageway edges shall be subject to approval.

8.3 Damage to roads and streets

If through the improper use of excavating machinery or through carelessness or for any other avoidable reason the Contractor excavates trenches to greater widths than are specified, or if in the remaining portions of roadways, pavement or footpath, damage is done to surfaces by heavy machinery the Contractor shall be entirely responsible for the complete restoration of the surfaces so damaged and shall himself restore them to the condition in which they were before the Contractor commenced his operations, or shall pay to the owner or Local Authority the certified costs of such repairs.

8.4 Interference with underground services

The Contractor shall comply with the "Code of Practice for Avoiding Danger from Underground Services" published by the Health and Safety Authority in February 2005.

Before the commencement of work in any area where there is likelihood of interference with Underground Services of any kind, the Contractor must first of all consult with all the Service Authorities and obtain from them site location information.

Where locations of existing services are identified following consultation with the Services Authorities the Contractor shall if necessary carry out trial excavations or other investigations so that all available information regarding the service may be obtained before excavating in the vicinity of same. Where an unanticipated service is encountered in excavation the Contractor shall immediately call the attention of the Employer's Representative Site Staff and the appropriate Authority thereto.

A proper record shall be kept to show the precise position of services encountered. Location seeking of the various services can only be carried out under the supervision of the particular Authority concerned with that service.

The Contractor shall make all arrangements for the temporary shoring up and supporting, diversion when permitted by the owner, and keeping in operation all sewers, drains, land drains, gas, water and other pipes, culverts, electricity and telephone cables, etc., as may be affected, disturbed or exposed by his operations. In the event of any damage during or after the execution of the Works, he shall immediately notify the Authority or owner concerned and shall be liable for the full cost of such remedial works as may be determined by that Authority or owner and including consequential damage to the property of third parties which may arise from the execution of the Works.

Where permanent diversion or permanent support is rendered necessary as the unavoidable result of the construction of the Works in accordance with the Contract or where in the opinion of the Employer's Representative Site Staff the position of existing services over 75mm external diameter which cross the permanent work for a distance not less than five times the net width thereof warrants temporary diversion or support the Employer's Representative Site Staff will instruct the Contractor accordingly.

Before commencing any work which may affect the flow in any sewer or storm drain the Contractor shall submit, and obtain the approval of the Employer's Representative to, his detailed proposals for maintaining or temporarily diverting the flow. Standby pumping equipment with day and night attendance shall be provided where the Contractor proposes to pump the flow and in general he shall provide and fix all necessary dams, chutes, tanks and other plant and labour as may be required.

Temporary pumping for diversions or overpumping of existing sewers shall be arranged with electrically operated pumps from ESB mains supply as the continuous 24 hour running of diesel pumps or generators adjacent to residential properties will not be permitted.

The Employer's Representative will not approve any proposal for the temporary diversion of flow, which does not provide capacity equal to or greater than that which it replaces or which unnecessarily affects the sewer conditions upstream. Notwithstanding that such works may be required only for a limited period they shall if so required by the Employer's Representative be constructed to a standard similar to that specified for the permanent works.

Any temporary works constructed for the diversion of flow shall be entirely removed and the connections to the existing structures made good if and when the Employer's Representative shall so order. Where the Employer's Representative considers that the removal of the temporary works would involve risk to the permanent works or other structures or would give rise to undesirable further opening up of ground surfaces he may direct the Contractor that such temporary works are to be cleaned out and filled in as specified.

8.5 Obstruction of roads

The Contractor shall not occupy or obstruct by his operation more than one half of the width of any road or street.

If it becomes necessary with the approval of the Local Authority first obtained to restrict traffic to a single lane, properly trained and alert flagmen shall be provided to direct traffic. One-way traffic will not be permitted over continuous lengths of road exceeding 100 metres except in very exceptional circumstances or where the density of traffic is light.

9 Landscaping and Openspace

9.1 Landscaping

Grading of general landscaped areas to be carried out to subsoil level. Costs to be included for all aspects of landscaping including topsoil and planting as specified on Landscaping drawing.

Grass seeding shall be carried out in accordance with British Standard specification 4428; 1989, entitled "Code of Practice for General Landscape Operations", Section 5. Topsoil shall conform to the description of topsoil set out in British Standard Specification No. 3882; 1994, entitled "Specification for Topsoil". Topsoil shall be good quality medium topsoil loam, easily moulded when moist. It must not include subsoil, excessive proportions of clay, sand, chalk or lime, nor may it include rubbish or other extraneous material, pernicious weeds or couch grass whether roots or top growth, or roots of trees or shrubs. A minimum depth of 150mm of topsoil is required.

9.2 Imported Topsoil And Turf

Imported topsoil shall comply with BS 3882 and be of light or medium texture, having a pH value of between 6.0 and 7.5. Imported topsoil shall not contain stones greater than 50mm in size, or have a total stone content exceeding 10 per cent by mass.

All areas for planting or grassing to be deep ploughed to a depth of 600mm in parallel runs at 1200 c/c using a 75 dia. Mole.

Imported turf shall comply with BS 3969 and be delivered to the site within 24 hours of lifting (18 hours in spring and summer). Constituent grasses and their proportions shall comply with the provisions of BS 3969: 1998, Clause 3. Good practice dictates that turves shall be green when cut, they shall be kept moist and shall be re-laid in suitable weather conditions. The level of topsoil beneath the turves shall be such that the final grass surface after compaction shall be flush with the adjoining grass surface.

9.3 Land Drains

The positions of all land drains intercepted and disturbed shall be prominently marked at every point of intersection with the work. The Contractor shall record these positions, depths, pipe diameters and the types of construction, and a copy of these records shall be given to the Employer's Representative. Care shall be taken during the progress of the Works to prevent the disturbance of markers.

Prior to the permanent reinstatement of land drainage the Contractor shall clear the ends of existing drains, where intercepted by excavations, and shall afford facilities to the Employer's Representative and the landowner or occupier to inspect them and determine the extent of replacement that may be necessary.

The backfill of intercepting excavations shall be compacted in 200mm layers, to give a firm bearing immediately before replacement pipes are laid, and shall be brought up to the level of the underside of the land drains or of any support to be provided.

The affected land drains shall be cut back into firm ground until, in each case, a section is exposed which is unaffected by the Works.

Replacement pipes or support beams shall bear on undisturbed ground for at least 500mm at each end. The replacement pipes shall be of the same internal diameter as the sections of drain, which they replace, and shall be properly connected at each end.

Records shall be kept of all drainage system reinstatement work carried out and a copy shall be given to the Employer's Representative.

10 Demolition

10.1 General

Demolition work shall be carried out in accordance with British Standard Codes of Practice; BS6187: 1982 (Code of Practice for Demolition and BS 5228 Pt 1, 2 & 4 (Noise and Vibration Control), or any other relevant code of practice.

The necessary demolitions, removals and alterations are shown on the drawings. These shall be carried out carefully with regard to existing surroundings.

The order and method of each operation is to be submitted to the Architect/Engineer for review prior to commencement. This to include proposed methods of propping, shoring, protection of adjoining areas, property, retained structures et cetera.

Notwithstanding any information given in the Contract documents, the onus shall be on the Contractor to visit the site of the works and satisfy himself as to the nature and extent of the work and all other matters that might influence his price or time for completion of the works. Arrangements to visit the site should be made with the Client/Engineer.

10.1.1 Retained Property/Temporary Works

The demolitions shall be carried out without damage to retained property or adjoining areas. If such damage should occur, through negligence in the carrying out of this demolition, the contractor shall reinstate and make good at his own expense. Any such reinstatement shall be executed with materials and workmanship to match the existing work.

10.1.2 Working Hours

Demolition Work shall be carried out during the hours as set out in the Planning Guidelines. The Contractor shall liaise with the Engineer with all matters relating to the Planning Conditions.

10.1.3 Supervision

Demolition work to be carried out under the supervision of a responsible and competent person experienced in demolition work who shall ensure that adequate safety precautions are taken at all times, and that all necessary statutory regulations are fully adhered to.

Before commencement of works, the Contractor is to advise the Client in writing of the name and contact details of the Contractor's Site Manager.

10.1.4 Safety

The Contractor shall perform the demolition works in accordance with Safety, Health and Welfare at Work (Construction) Regulations 2013, as amended.

Ensure the safety of the works and public during demolition work. Carry out demolition work in such a manner as to cause the minimum inconvenience to the staff, public and to adjoining owners.

The Contractor will be held responsible for any claim that may arise from disregarding this clause.

10.1.5 Plant and Equipment

All demolition plant equipment is to be:

- Of suitable types and standards for location and type of work.
- In the charge of competent operators.
- Maintained in good working condition.

Materials arising from the demolitions are to become the property of the Contractor and are to be removed from site as the work proceeds. Credit should be allowed at the end of the demolitions section for any materials upon which the Contractor places a value and the Employer reserves the right to retain or purchase any or all of the materials at the credit value shown, should he so wish. If any items are not so listed, it will be deemed that the contractor regards the materials concerned as having no value.

10.1.6 Making Good

All making good after demolition and removal either shown or described on the drawings, or inferable, or necessary shall be carried out, in all trades, to the Engineers satisfaction.

10.1.7 Avoidance of Nuisance

The rubbish etc. is to be well sprinkled with water to prevent dust arising and prices for the carrying out of work shall include for all necessary scaffolding and plant and for the removal off site of all materials not being re-used.

10.1.8 Re-instate and Make Good

All taking down shall be carried out without damage to adjoining property and if such damage shall occur, the Contractor shall reinstate and make good the same at his own expense. Any taking down in excess of what is intended shall be made good together with any consequential work at the Contractor's expense.

10.1.9 Temporary Hoardings

The Contractor shall provide and maintain all necessary temporary fencing, hoardings, fans, planked footways, guard rails, gantries and the like for the protection of the public and for meeting the requirements to the Local Authority. Allow for altering, shifting and adapting from time to time as necessary. It is the Contractors responsibility to apply for a hoarding licence and pay the relevant fees.

10.1.10 Demolitions and Cutting

Demolition and cutting of reinforced concrete must be carefully executed and is to be carried out by a specialist sub-contractor. The specialist sub-contractor shall have the necessary plant, tools and equipment to carry out the accurate cutting and demolition of reinforced and concrete walls and floors and shall have extensive experience in the execution of this type of work. The sub-contractor shall also

carry demolition insurance. Cutting is to be carried out so that the cut surfaces, which remain after the cutting operations, are smooth and square to the walls and floor and without spoiling and unevenness of the concrete cut surface.

The Demolition Contractor shall scabble and roughen the cut face of all demolition cut surfaces where materials are to be bonded or applied over the cut surfaces. (all in compliance with the current safety regulations and with a minimum of risk for the operators).

The specialist sub-contractor shall carry out all necessary work for the complete demolition, cutting, and removal from site of waste demolition material. The sub-contractor shall carry out the drilling of any holes in the work for lifting or lowering or other purpose and shall provide all temporary angled or other propping for the stabilisation of cut pieces prior to their removal by him from existing position.

The specialist sub-contractor shall liaise with the Main Contractor with regard to all operations of the sub-contract. He shall also liaise with the Main Contractor with regard to the Main Contractor's performance of work and site operation and agree on the integration of his work with the main contractor's programme.

10.1.11 Methods of Demolition

The Main Contractor shall clearly indicate by Method Statement in writing the manner of demolition i.e. machine, mechanical tools, piece by piece hand method etc., for each area and specifically for adjoining existing buildings and boundaries.

It should be noted that demolition must be closely linked in with the provision of any temporary support required to adjoining buildings and the facade. All methods used shall ensure an orderly and safe transfer of the loads from the existing to the temporary works and to the permanent structure.

10.1.12 Completion

When the Contractor considers that the whole of the Works relating to the demolition of the building has been completed, he shall give written notice to that effect to the Client's Engineer.

The site is to be left neat and tidy to the satisfaction of the Main Client, Engineer and Architect.

10.2 PRELIMINARY WORK

10.2.1 Services

Arrange with appropriate authority for the location and marking of the position of services affected by the demolition work.

The Contractor is responsible for ensuring that all services, electricity, gas, telecommunications, water, sewerage etc., are made safe prior to demolition.

Any damage to services that are required to be maintained are to be made good at the Contractors expense. Any services that are required on site by the Contractor during the works are to be included in the contract sum.

The contractor is responsible for the protection of overhead cables. He is to provide suitable measures to ensure all necessary precautions are undertaken and should have them clearly marked to ensure immediate identification.

10.2.2 Plans

Examine all available plans of buildings or structures to be demolished.

10.2.3 Disconnection of Services

Before starting demolition work, arrange with the appropriate authority for the disconnection of services and removal of fittings and equipment. Pay all charges for disconnection of services.

10.2.4 Schedules of Dilapidations

The Contractor is to include in his price for the works the carrying out of a schedule of dilapidations on all adjoining properties. This Schedule should be in the form of pictures and sketches including all defects noted in the properties. These schedules are to be provided to the Architect/Engineer and will require to be agreed between all parties including adjoining owners prior to demolition. After the works are complete the adjoining properties are to be inspected to ensure that no deterioration has taken place as a result of the demolition works. All costs associated with discussions/meetings with adjoining owners or their representatives are deemed to be included in the contract sum.

10.3 PRECAUTIONARY MEASURES

10.3.1 Partly Demolished Structures

Prevent access of unauthorised persons to partly demolished structures. Leave safe at close of each day's work.

10.3.2 Dangerous Openings

Illuminate and protect as necessary.

10.3.3 Overloading

Prevent debris from overloading any part of the structure.

10.3.4 Dust

Debris shall be watered where necessary to prevent the rising of dust. The demolition site is to be kept in a safe condition and materials shall not be stored in a manner likely to cause injury or nuisance to people on the site and adjoining owners. The Contractor shall make arrangements that debris, dirt etc is not allowed accumulate outside the site. All public roads and footpaths are to be kept clean.

The Contractor shall ensure that all public roads and pathways in the vicinity of the demolition works are at all times kept clear of waste and mud falling from vehicles connected with the Works, or soiling or staining of the public road as a result of the Works in any way.

10.3.5 Support

Existing structure as necessary during cutting of new openings or replacement of structural parts. Do not remove supports until new work is strong enough to support the existing structure.

10.3.6 Protect

Parts of existing building which are to be retained. Cut away and strip out with care to reduce the amount of making good to a minimum.

10.3.7 Shoring Props, Etc.

It shall be for the Contractor to judge whether or not any necessary removal or demolition gives rise to the need for temporary shoring or props. He shall be deemed to exercise expert judgement in this matter. The decision to use or not use shoring or props rests with the Contractor who shall be solely liable for the proper design of any shoring or props, shall be liable for any damage resulting from failure to use temporary supports in any situation where common practice and prudent judgement indicate that they required to be used.

10.3.8 Noise

The attention of the Contractor is drawn to the particular requirements of the Contract to minimise the noise created by the works. He is required to take all necessary precautions to reduce noise and to not create noise during the periods stipulated in the Contract.

10.3.9 Monitoring of Adjacent Buildings

It may be a requirement that adjacent buildings have movement monitoring equipment (tell tales) installed before or during demolition. The Contractor shall provide suitable ladders and assistance for installation.

10.3.10 Protection of Property, Public, Hoardings

The Contractor shall provide and erect to the satisfaction of the Employer all necessary protective screens or scaffolds that may be required, of a sufficiently substantial nature to prevent damage, nuisance or disturbance by debris or dust to adjoining properties, public highways or persons or traffic passing nearby.

During the demolition works no wall or part of the structure shall be left in a dangerous or insecure condition at any time when a representative of the Contractor is not on the site, and adequate barriers and (after darkness) lamps shall be provided to warn users of the public highway of any obstruction or danger.

The Contractor shall bear in mind that demolition sites are of special attraction to children and shall take all reasonable precautions to warn children of the danger of trespassing and to deter them from so doing. The Contractor must keep all public footpaths adjoining the sites available at all times for use by the public, and the stacking of timber and other materials thereon is expressly forbidden.

The contractor shall perform the demolition works with respect to the wind direction and shall implement all appropriate and necessary measures to ensure minimal dust nuisance to the surrounding environment.

The demolition of the property is to be carried out in such a manner as to cause as little inconvenience to adjoining property owners and/or the public as possible, and the Contractor will be held responsible for any claim which may arise from disregard of this clause.

10.3.11 Pricing on Site

The Contractor is deemed to have visited the site and ascertained the full extent and nature of the demolitions.

10.4 Materials Arising

10.4.1 Contractors Property

Components and materials arising from the demolition are deemed to be the property of the Demolition Contractor except where otherwise provided. The Contractor is responsible for its safe removal from site as work proceeds.