



McKenna Consulting Engineers
Civil & Structural

Structural Engineering Specification

for

Environmental Protection Agency (EPA) - Wexford

at

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TABLE OF CONTENTS

1.0	Excavations and Loose Fill Work	3
1.1	Excavating Work.....	3
1.2	Filling Work.....	6
1.3	Excavations and Fill Work for Structures & Pipelines.....	9
2.0	Concrete Work	12
2.1	Materials Generally	12
2.2	Concrete Requirements	15
2.3	Concrete - Requirements for Designed Mixes.....	21
2.4	Concrete Production	23
2.5	Concrete - Compliance	25
2.6	Concrete - Construction General	27
2.7	Reinforcement	36
2.8	Worked Finishes to In Situ Concrete.....	40
3.0	Structural Steelwork	41
3.1	Materials	43
3.2	Workmanship.....	
4.0	Blockwork	47
4.1	Preparation	47
4.2	Laying Blocks and Bricks Generally	47
4.3	Cavity Walls.....	48
4.4	Mortar	49
4.5	Accuracy	51
4.6	Adverse Weather	52
4.7	Reinforcing/Fixing Accessories	53
4.8	Lintels	53
4.9	Collar Jointed Walls	54
4.10	Testing	54
5.0	Cement Sand/Concrete Screeds/Toppings	54
5.1	Types of Screed/Topping	54
5.2	Generally/Preparation	55
5.3	Batching/ Mixing/ Laying	55
5.4	Finishing/Curing.....	56
6.0	Precast/Prestressed Hollowcore Floors.....	57
6.1	Types of Screed/Topping	57
6.2	Generally/Preparation	58
6.3	Batching/ Mixing/ Laying	58
6.4	Finishing/Curing.....	58
6.5	Types of Screed/Topping	58
6.6	Generally/Preparation	58
6.7	Batching/ Mixing/ Laying	58
6.8	Finishing/Curing.....	58



7.0	Timber	59
7.1	General Information/Requirements	59
7.2	Type(s) of Timber	59
7.3	Workmanship Generally.....	59
7.4	Jointing Timber	60
7.5	Erection & Installation	60
7.6	Planed Sizes, Constructional Timber	60
7.7	Processed Stress Graded Timber	60
7.8	Distortion.....	61
7.9	Flatness....	61
7.10	Workmanship - Structural	62
7.11	Laminated Timber Members	63

Appendix -



1.0 EXCAVATIONS AND LOOSE FILL WORK:

1.1 Excavating Work:

1.1.1. Materials - Definitions:

'Solid Rock' shall mean rock in natural wedges or masses, which can be moved only by blasting by pneumatic or hydraulic tools or similar equipment, or by wedges and sledgehammers. All solid boulders or detached pieces of rock exceeding 1.0m³ in size shall be regarded as solid rock.

'Topsoil' shall mean soil capable of supporting plant growth.

1.1.2. Site Conditions:

The Contractor shall make all necessary further enquiries about the nature of the ground.

The Contractor, before submitting his tender, will be permitted to dig trial holes subject to approval. The Contractor shall consult the responsible authorities before commencing excavation about the position and type of underground services, which are likely to be encountered.

1.1.3. Topsoil Excavations:

Stockpile excavated topsoil in temporary spoil heaps where directed. Keep separate from other materials.

1.1.4. General Excavation:

Excavate to the dimensions, levels, lines and profiles shown on the drawings or as directed.

Permissible deviations from formation are as follows:

Where an excavation encroaches below a line drawing at an angle 30° from the horizontal from the nearest formation level of another higher excavation, all work within it and backfilling there to must be completed before the higher excavation is made.

Backfill unauthorised or excess excavations with approved filling at no expense to the Employer.

ACCURACY: Permissible deviations from formation levels:

- Beneath mass concrete foundations: +/- 25mm.
- Beneath ground bearing slabs and r.c. foundations: +/- 15 mm.
- Embankments and cuttings: +/- 50 mm.
- Ground abutting external walls: +/- 50 mm, but such as to ensure that finished level is not less than 150 mm below dpc.



FORMATIONS GENERALLY:

- Make advance arrangements with Engineer for inspection of formations for the following:
Service trenches
Road and Pavings
- Remove the last 75 mm of excavations just before inspection. Trim excavations to required profiles and levels, and remove all loose material.
- Unless otherwise instructed seal formations within 4 hours of inspection with concrete or other specified fill.

TRENCH FILL FOUNDATIONS:

- Excavate the whole depth of the trench down to formation by machine in one operation. Make advance arrangements with Engineer for inspection of formation as soon as it is exposed.
- Unless otherwise instructed place concrete immediately after inspection.

RECORDED FEATURES: Break out old foundations, beds, drains, manholes, etc. where and to the extent stated on the drawings. Seal off drain ends, remove contaminated earth and disinfect as required by Local Authority. Backfill as specified on drawings.

UNRECORDED FEATURES: Where old foundations, beds, voids, basements, filling, tanks, pipes, cables, drains, manholes, watercourses, ditches, etc. not shown on the drawings are encountered, do not disturb or enter and obtain instructions before proceeding.

If, in the Contractor's opinion, a bearing stratum is obtained at a lesser depth than that shown on the Drawings, he shall inform the Engineer.

ADDITIONAL / UNAUTHORISED EXCAVATION: Any additional excavation required to accommodate the temporary support of sides of excavations shall be provided and backfilled at the Contractor's expense. Backfill unauthorized or excess excavations with approved filling at no expense to the Employer

1.1.5. Disposal of Water:

Keep excavations free from surface water.

Keep excavations below ground water level free from water.

Do not pump water from excavations into permanent drainage system.

Where continuous pumping is proposed, notify the Engineer.

Prevent silt from entering the permanent drainage system when disposing of water from excavation.

Where temporary sumps are required, construct them clear of excavations for permanent work and fill them with suitable filling when no longer required.



1.1.6. Disposal of Materials:

EXCAVATED TOPSOIL: Stockpile as directed

ALL SUBSOIL: Spread and level all subsoil or remove from site, as directed.

1.1.7 Existing Drainage:

All disused drainage having crown level within 600mm of formation level, of any structure, shall be grubbed up and removed. Disused drainage located below this level shall be sealed with grout. The grout to be used shall have minimum water content sufficient only to allow it to be pumped to the end of the pipe. All abandoned manholes under the building footprint shall be demolished to a depth of 600mm below formation level and shall be filled with well-compacted Clause 804 granular material. All excavations shall be filled with well-compacted Clause 804 granular material.

1.2 FILLING WORK:

1.2.1. Materials - Definitions:

Type A Granular material shall consist of natural sands, gravels, crushed rock, crushed slag, crushed concrete or well-burnt non-plastic shale and shall lie within the grading envelope specified in Clause 803 as specified in the DoE 'Specification for Road Works'.

BS Sieve Size	% by weight passing
75mm	100
37.5mm	85-100
10mm	45-100
5mm	25-85
600um	8-45
75um	0-10

The particle size shall be determined in accordance with BS1377. The material passing the 450um BS sieve, when tested in accordance with BS 1377, shall have a plasticity index of less than 6. Material used shall be frost resistant.

Type B Granular material shall consist of crushed rock, crushed slag, crushed concrete or well-burnt non-plastic shale and shall meet the requirements of Clause 804 of the DoE. The material shall be well graded and lie within the following grading envelope as specified in the DoE 'Specification for Road Works'



BS Sieve Size	% by weight passing
75mm	100
37.5mm	85-100
10mm	40-70
5mm	25-45
600um	8-22
75um	0-10

The particle size shall be determined in accordance with BS1377. The material passing the 450um BS sieve, when tested in accordance with BS 1377, shall be non-plastic. Material used shall be frost resistant. The material shall be laid and compacted to the requirements of Clause 802, without drying out or segregation.

With the exception of well burnt non-plastic shale, the material shall have a ten per cent fines value of 5 or more when tested in accordance with B.S. 812

'Suitable earth filling' shall mean material either arising from excavation or imported which is capable of being compacted as specified.

'Unsuitable Filling Material' shall mean any of the following;

- Perishable material
- Material from marshes or bogs
- Logs, stumps, slurry and mud
- Material susceptible to spontaneous combustion
- Material in a frozen condition
- Clay of liquid limit exceeding 80% and/or plasticity index exceeding 55 as determined with BS 1377 or equivalent
- Materials with water soluble content (as SO₄) in excess of 0.1%
- Materials having moisture content greater than the maximum permitted

1.2.2. Quality Control:

Submit samples for laboratory testing as instructed. Each sample of grained cohesive soil shall weigh at least 25kg. Each sample of coarse grained non-cohesive soil shall weigh at least 55kg. Soil samples shall be taken in accordance with CP2001.

The Contractor will be notified, after receipt of laboratory test results, of approved type of filling materials.



1.2.3. Filling and Compaction Work:

PLACING FILL GENERALLY:

- Ensure that excavations and areas to be filled are free from loose soil, rubbish and standing water.
- Do not use frozen materials or materials containing ice. Do not place fill on frozen surfaces.
- Take all necessary precautions to avoid overloading of adjacent structures and to ensure stability. Place and compact fill against structures, membranes or buried services in a sequence and manner which will ensure stability and avoid damage.
- Plant employed for transporting, laying and compacting must be suited to the type of material.
- Lay differing materials separately so that only one type of material occurs in each layer.

Compact and consolidate each layer of fill thoroughly in max. 225mm layers

Compact granular material by not less than ten passes of a towed vibratory roller with a static load of at least 50kg per 25mm of roll or a grid roller with a load of at least 225kg per 25mm width of roll. Where use of roller is impractical compact gravel using suitable mechanical rammer.

BENCHING IN FILL: Where, during the progress of the work, the difference in level between adjacent areas of filling exceeds 600 mm, cut into edge of higher filling to form benches having a minimum width of 600 mm and a height equivalent to the depth of a layer of compacted filling. Spread and compact new filling to ensure maximum continuity with the previous filling.

COMPACTED LANDSCAPE FILLING:

- Materials arising from the excavations or imported, capable of compaction by light earthmoving plant, and excluding the following:
 - Material from marshes or bogs;
 - Peat, logs, stumps, slurry, mud and perishable material;
 - Material susceptible to spontaneous combustion;
 - Material in a frozen condition;
 - Clay of liquid limit exceeding 80 and/or plasticity index exceeding 55;
 - Material with excessive moisture content;
 - Material likely to erode or decay and cause voids;
 - Unacceptable material class U2 as defined in clause 601 of the Highways Agency 'Specification for highway works'.
- Lay in layers not more than 200 mm thick and lightly compact each layer with the earthmoving plant to produce a stable soil structure.

COMPACTED GENERAL FILLING:

- Compact and consolidate each layer of fill thoroughly in max. 225mm layers.
- Adjust the moisture content of the fill as instructed. Provide all necessary water sprinkling equipment.
- Spread and level material in layers and as soon as possible thereafter compact each layer using plant and methods suitable to the type of material.



- Compact suitable imported earth filling in accordance with Table 6/2 of the “Specification for Road Works”, published by the Department of the Environment.
- Compact all hardcore in accordance with Table 8/1 of the “Specification for Road Works”.

PROTECTION OF COMPACTED FILLING:

- Do not allow construction traffic on compacted cohesive soil filling until the level has been raised not less than 150 mm above formation level by properly compacted temporary protective filling.
- Remove temporary protective filling from site before beginning permanent construction.

BACKFILLING TO FOUNDATIONS:

- Under oversite concrete and pavings: Hardcore as specified.
- Under grassed or landscaped areas: Material excavated from the trench, laid and compacted in layers not exceeding 300 mm thick.

GRANULAR FILL / HARDCORE UNDER CONCRETE SLABS & FOOTPATHS: to be as specified and in strict accordance with SR21 2014 + A1:2007 – Guidance on the use of IS EN 13242:2002, not less than 450 mm thick. Excavate extra material as necessary. Increase thickness of hardcore as necessary to make up levels from stripped site levels to underside of slabs.

BLINDING: All blinding to be 10 N concrete to all foundations.

1.3 EXCAVATIONS AND FILL WORK FOR STRUCTURES & PIPELINES:

1.3.1 Breaking Out and Stripping Surface Material:

Before general excavation is commenced, all surface material shall be carefully broken out or stripped and set aside separately from general excavation for re-use as specified or as directed by the Engineer's Representative. In the case of grasslands, the topsoil over the entire wayleave width or as directed by the Engineer shall be stripped and set aside separately. In the case of bitumen, macadam or concrete road slabs, the macadam or the slab shall be cut at least 300mm back from the edges of any excavation. Concrete slabs shall be cut with a concrete saw.

1.3.2 Extent of Excavation:

The maximum allowable trench widths for various pipe sizes shall not exceed those specified on the relevant drawing(s). These widths shall not be exceeded from the formation level up to a height of at least 300mm over the pipe barrel. Trenches may be sloped back or stepped above this level subject to exclusions noted hereafter.



In the case of pipes with concrete bedding the minimum trench widths at formation level will be the width of the concrete bed plus 150mm. Where granular bedding is used, the minimum trench width shall be the width of the granular bed. The dimensions of concrete and granular beds are given on the Manhole Detail Drawing.

The extent of other excavation in open cut shall be the minimum necessary as practicable for the construction of the Works. No excavation of any kind with battered sides will be permitted in public roads, private gardens or within 20 metres of any building or other structure.

1.3.3 Support of Excavation:

The Contractor shall secure all excavation with suitable supports. If, in the Engineer's opinion, the supports are insufficient the Contractor shall alter or strengthen the supports to the Engineer's satisfaction and he will not be paid for any additional cost incurred by him in so doing. No support shall be removed from excavation until, in the opinion of the Engineer's Representative, the permanent work is sufficiently advanced to allow such removal. Any such permission given by the Engineer's Representative for the removal of support shall not relieve the Contractor of his responsibilities under the Contract.

1.3.4 Excavation Free from Water:

All excavation shall be kept free from water from whatever source arising so that the Works shall be constructed in dry conditions throughout. The water level shall be kept below the bottom of the permanent work for such period as the Engineer's Representative shall direct. In the event of drainage channels or sub-drains being required, details of same shall be submitted to the Engineer and they shall be constructed to his satisfaction. In cases where these are permitted below the level and within the width of the permanent work, they shall, if left in place, provide support at least equal to the permanent support. No sub-drainage pipes shall be left in unless they are filled with concrete Grade C8/10. No water shall be discharged into any water course or sewer, including those sewers laid under the Contract, without the Contractor having first obtained all necessary consents and the permission in writing of the Engineer. Such permission shall not be granted unless the Contractor shall have provided, to the satisfaction of the Engineer's Representative, an efficient settling basin or sand-trap through which all such water shall pass before discharge into the said watercourse or sewer.

1.3.5 Formation Level:

The formation level of trenches shall not be exposed until immediately prior to laying of concrete blinding or bedding material.

1.3.6 Unsound Foundation:



All unsound material in the bottom of excavations shall be excavated and the resulting space filled in with concrete Grade C8/10 or granular sub-base material as directed by the Engineer.

1.3.7 Deposition and Protection of Excavated Material:

Excavated materials shall be deposited as compactly as possible along the sides of the trench. Margins of 600mm at least shall be kept between the spoil and the edges of the trench. Where the excavated materials cannot be deposited alongside the trench, they shall be removed as soon as excavated and such portions thereof as may be required shall be brought back for refilling of the trench. The cost of such work shall be deemed to be included in the Contractor's rates for general excavation. Where excavated material containing clay is to be used for refilling in road trenches, it shall be protected from excessive wetting or drying. If, in the opinion of the Engineer, such material has become unfit for use as refill as a result of the Contractor's failure to protect same, it shall not be used and the Contractor shall, at his own expense, provide gravel fill as required by the Engineer.

1.3.8 Support of Existing Structures and Services.

The Contractor shall be responsible for maintaining all sewers, drains, pipes, cables and other services and structures encountered in excavations. While the locations of some services adjacent to or crossing pipelines may be shown on the Drawings, no guarantee is given that these are the only services likely to be encountered and the Contractor shall make provision accordingly in his tender. All services shall be temporarily supported or diverted during the construction of the Works and subsequently amended, altered or remade to the reasonable satisfaction of the Engineer and the person, company or authority in whom they are vested. Temporary supports and diversions shall be deemed covered in the rates for excavation.

1.3.9 Maintenance of Flow.

The Contractor shall allow for the maintenance of flow in all sewers or storm drains affected by the Contract Works.

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 Engineer to his detailed proposals for maintaining or temporarily diverting the flow. Stand-by 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.



The Engineer will not approve any proposal for the temporary diversion of flow which does not provide capacity equal to or greater than that 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 Engineer, be constructed to a standard similar to that specified for the permanent work. Any temporary works constructed for the diversion of flow shall be entirely made good if and when the Engineer shall so order. Where the Engineer 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.

1.3.10 Refilling of Trenches other than in Public Roads.

On completion of each length of pipeline and after testing and approval by the Engineer's Representative, the side filling above the concrete or granular benching or bed as the case may be, shall then be placed on both sides of the pipe in layers not exceeding 150mm and carefully compacted by hand up to the top of the pipe. This filling shall consist of uniform readily compactable material free from tree roots, vegetable matter, frozen soil, large clay lumps or stones exceeding 75mm. Following this, a protective covering of similar material shall be placed over the pipe barrel to a minimum depth of 300mm evenly compacted by hand or by light mechanical tamper in layers not exceeding 150mm. The remainder of the trench to within 300mm or 225mm as the case may be, of the previously existing surface shall be filled in layers not exceeding 300mm and well consolidated by hand or mechanical tamper. The best of the excavated material only shall be used for refilling and all surplus material shall be removed forthwith and disposed of by the Contractor.

2.0 CONCRETE WORK:

2.1 MATERIALS GENERALLY:

All materials shall comply with the requirements of the appropriate Irish, European or British Standard.

Cement:	I.S.1 and EN 197-1
Aggregates:	I.S. 5 or B.S. 882
Hot Rolled Steel Bars:	BS 4449
Cold Worked Steel Bars:	BS 4461
Steel Fabric:	B.S. 4483
Admixtures:	B.S. 5075, Parts 1, 2, 3
Mixing Water:	BS 3148 or EN1008:2002



2.1.1. Cement:

Cement shall either be certified as complying with I.S. 1 and shall bear the I.S. Mark or shall be certified to a 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. Cement shall conform to EN 197-1.

Cement shall be normal setting Portland Cement of an approved brand. Cement shall be delivered to site in unbroken bags as delivered by the manufacture or in approved bulk delivery vehicles. Manufacturers test certificates shall be provided as required by the Engineer.

Cement shall be stored under weatherproof conditions, on a raised floor, or in suitable silos. Any cement that has become injuriously affected by damp or other causes shall be removed from site immediately. The use of cements of the same type from different sources will not normally be permitted.

2.1.2. Aggregates:

Details of proposed aggregates should be provided for the Engineers approval. Unapproved aggregates may not be used on the project.

Coarse and fine aggregates from natural sources shall comply with IS 5 or BS882. Aggregates of which only the grading does not comply with the above codes may be approved.

The chloride content of aggregate shall be such that the total chloride content of the concrete mix shall not exceed 0.1% for pre-stressed concrete, 0.3% for reinforced concrete expressed as percentage of chloride ion by weight of cement. Chloride levels shall be determined daily in accordance with IS5 Part 3.8 or as otherwise agreed by the Engineer.

The shell content of the aggregate included as calcium carbonate as determined by the method in IS5 Part 3.3 shall not exceed the following amounts:

Nominal size (mm)	%
40	2
20	5
10	15
Fine	30



The flakiness index (when determined by the sieve method described in IS5 (Part 3.2) of the coarse aggregate shall not exceed 35% for 10mm aggregate nor 30% for 20mm aggregate.

For concrete grade 40 or higher the ten per cent fines value of the coarse aggregate determined in accordance with IS5 Part 3.9 shall be not less than 100kN and for other grades not less than 50kN.

2.1.3. Water:

The water to be used in the mix shall be clean and free from harmful matter. If water for the works is not available from a Public Utility Undertaking Supply, the Engineers approval shall be obtained regarding the source of supply and manner of its use. When required by the Engineer, the Contractor shall arrange for tests of the water to be carried out in accordance with BS 3148 or EN1008:2002. Water from the sea or tidal rivers shall not be used.

2.1.4. Admixtures:

The quantity and method of using admixtures shall be in accordance with the manufacturer's recommendations and in all cases shall be subject to approval by the Engineer. Unless otherwise specified or approved by the Engineer, an admixture shall comply with one of the following:

BS1014 (Pigments for Portland Cement and Portland Cement Products)

BS5075 (Concrete admixtures) (except chloride -based admixtures)

In all cases, the Contractor shall provide the following information for the Engineers approval:

- (a) The quantity to be used, in kilograms per kilogram of cement and in kilograms per cubic metre of concrete.
- (b) The detrimental effects caused by adding greater or lesser quantity in kilograms per cubic metre of concrete
- (c) The chemical name(s) of the main active ingredient(s)
- (d) Whether or not the admixture leads to the entertainment of air.

If required by the Engineer, the Contractor shall demonstrate the action of an admixture by means of trial mixes. The use of calcium chloride in any form is prohibited.



2.2 CONCRETE - GENERAL REQUIREMENTS:

2.2.1. Concrete Grade and Class:

For each grade of concrete, the specified characteristic strength in N/mm² shall be as given in Table 3.1. The class of concrete shall be defined by its grade followed by the maximum size of aggregate allowed.

Table 3.1 Grades of Concrete

Grade	Characteristic Strength N/mm ² Cylinder / Cube
10	C8/10
15	C12/15
20	C16/20
25	C20/25
30	C25/30
35	C28/35
37	C30/37
40	C32/40
45	C35/45
50	C40/50
55	C45/55
60	C50/60
67	C55/67
75	C60/75
85	C70/85
95	C80/90
105	C90/105
115	C105/115

Table 2.2 Refer to national index Table 7 (Irl), p. 73 I.S. EN 206.

The Grade and Class of Concrete to be used for any part of the structure shall be as indicated on the drawings.

2.2.2 Exposure Class:

Main Exposure Classes refer to Table 1 p.15-17 I.S.EN 206



Class Designation	Description of the Environment	Informative examples where exposure classes may occur
1. No risk of corrosion or attack		
XO	For concrete without reinf't or embedded metal: All exposures except where there is freeze/thaw, abrasion or chemical attack. For concrete with reinf't or embedded metal: Very Dry	Concrete inside a building with very low air humidity
2. Corrosion Induced by Carbonation		
XC1	Dry or permanently wet	Concrete permanently submerged in water
XC2	Wet, rarely dry	Concrete surfaces subject to long-term water contact e.g. foundations
XC3	Moderate humidity	Concrete inside buildings with moderate or high air humidity. External concrete sheltered from air
XC4	Cyclic wet and dry	Concrete surfaces subject to water contact, not within exposure Class XC2
3. Corrosion induced by chlorides other than for sea water		
XD1	Moderate humidity	Concrete surfaces exposed to airborne chlorides
XD2	Wet, rarely dry	Swimming pools. Concrete exposed to industrial waters containing chlorides.
XD3	Cyclic wet and dry	Parts of bridges exposed to spray containing chlorides pavements. Car park slabs.
4. Corrosion induced by chlorides from sea water		
XS1	Exposed to airborne salt but not in direct contact with sea water	Structures near to or on the coast
XS2	Permanently submerged	Parts of marine structures
XS3	Tidal, splash and spray zones	Parts of marine structures
5. Freeze/thaw attack with or without de-icing agents		
XF1	Moderate water saturation, without de-icing agent	Vertical concrete surfaces exposed to rain and freezing
XF2	Moderate water saturation, with de-icing agent	Vertical concrete surfaces of road structures exposed to freezing and airborne de-icing agent



XF3	High water saturation, without de-icing agent	Horizontal concrete surfaces exposed to rain and freezing
XF4	High water saturation, with de-icing agent or sea water	Road and bridge decks exposed to de-icing agents. Concrete surfaces exposed to direct spray containing de-icing agents and freezing. Splash zones of marine structures exposed to freezing.
6. Chemical Attack		
XA1	Slightly aggressive chemical environment. Refer to Table 2 of EN 206-1: 2000 p. 18.	
XA2	Moderately aggressive chemical environment. Refer to Table 2 of EN 206-1: 2000 p. 18.	

2.2.3 Classification:

The various compressive strength classes of concrete shall be in accordance with the following table. A tolerance of + 5% in cement content will be permitted over a days output provided the designated weights are maintained as an average.

Concrete Mix Requirements	Concrete Grade				
	C32/40	C32/40	C28/35	C28/35	C28/35 (reduced w:c Ratio)
Max. Size of Aggregate (mm)	20	10	20	10	10
Min. Density of Compacted Concrete (kg/m ³)	2350	2350	2350	2350	2350
Min. Cement Content (kg/m ³)	350	350	325	325	325
Max. Free Water:Cement Ratio	0.5	0.5	0.55	0.55	0.45
Slump Class	S2	S2	S2	S2	S2
Plasticiser Permitted (Yes/No)	Yes	Yes	Yes	Yes	Yes
Min. 7 Day Cube Strength (N/mm ²)	26	26	23	23	23
Min. 28 Day Cube Strength (N/mm ²)	40	40	35	35	35



Concrete Mix Requirements	Concrete Grade					
	C25/30	C25/30	C25/30 (reduced w:c ratio)	C20/25	C16/20	C12/15
Max. Size of Aggregate (mm)	20	10	20	20	20	20
Min. Density of Compacted Concrete (kg/m ³)	2350	2350	2350	2300	2300	2300

Min. Cement Content (kg/m ³)	290	290	290	240	220	190
Max. Free Water:Cement Ratio	0.6	0.6	0.45	0.65	0.7	0.8
Slump Class	S2	S2	S2	S2	S2	S3
Plasticiser Permitted (Yes/No)	Yes	Yes	Yes	No	No	No
Min. 7 Day Cube Strength (N/mm ²)	20	20	20	16	14	10
Min. 28 Day Cube Strength (N/mm ²)	30	30	30	25	20	15

2.2.4. Minimum cement content and maximum water/cement ratio:

The cement content shall be not less than, and the water/cement ratio shall be not greater than described in the Contract. The sulphate content of the ground indicates that Class 1 and 2 Conditions (BS8004: 1986) apply and therefore all buried concrete shall have a minimum cement content (OPC) of 330 kg/m³ and a maximum free w/c ratio of 0.5.

2.2.5. Maximum Cement Content:

The cement content shall not exceed 450kg/m³ unless otherwise described in the Contract or agreed by the Engineer.

2.2.6. Maximum Sulphate Content:

The total water soluble sulphate content of the mix, expressed as SO₃ shall not exceed 4%. The sulphate shall be calculated as the total from the various constituents of the mix.

2.2.7. Control of Alkali - Silica Reaction:

Any one of Clauses (i), (ii) or (iii) shall be complied with. The Contractor shall indicate to the Engineer which of the procedures he proposes to adopt.

- (i) In concrete where the alkali content of the cement and the cement content of the concrete will not exceed 1.00% and 360kg/m³ respectively, paragraphs (a), (b) and



- (c) shall be complied with. The addition of secondary cementitious materials at the mixer is not permitted.
- (a) The alkali content of the Portland cement as described in paragraph below shall not exceed 1.00%.
 - (b) The cement content shall not exceed 360kg/m³.
 - (c) The alkali content of the Portland Cement shall be taken as the certified average acid soluble alkali content of the cement plus 1.64 standard deviations. The certified average alkali content shall be the average of the last 25 determinations of alkali content carried out on consecutive daily samples immediately prior to the submission of test certificates. The Contractor shall submit to the Engineer the test certificates furnished by the cement manufacturer. The alkali content of the Portland cement shall be determined in accordance with the method recommended in BS 4550 Part 2 or by the use of an x-ray fluorescence technique calibrated against that Standard.
- (ii) For protection of the structure by controlling the reactive silica content of the aggregates, the following shall be complied with:
- (a) Representative samples of the aggregates to be used shall be subjected to petrographic examination by a competent prapher approved by the Engineer. The definition of rock types shall be as per IS5 Part 3.14: Description and classification of aggregates.

Where the geological formation of the source material is complex, data from borings may be required to prove the nature of the parent strata.

The petrographer shall produce a report and shall quantify the presence if any of each of the potentially reactive constituents listed in Table 3.2. The report shall state the geological age of any chart discovered. Where the petrographer is evaluating a parent rock or gravel the report shall indicate the percentage of such constituents likely to remain in the aggregates after they have been processed to IS5.

The Contractor shall then provide the Engineer with a report showing the percentage of the potentially reactive constituents which will occur in the proposed concrete mix as a result of blending the coarse and fine aggregates.

If the content of potentially reactive minerals or rock is above the limits given in the second column of Table 3.2, the aggregates may be acceptable at the Engineer's absolute discretion following further assessment as per Clause 2.2.5 (ii) (b).

TABLE 2.3

Potentially reactive	Acceptable
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mineral or rock	Maximum Content
Opaline silica Cristobalite Tridymite	Zero
Microcrystalline and cryptocrystalline quartz, chalcedony	5%
Volcanic glass	5%
Highly strained * quartz	30% or less

* If the average undulatory extinction angle obtained from at least 20 separate quartz grains (measured in thin sections under a petrological microscope) is more than 25 degrees, the quartz shall be classified as highly strained.

- (b) Where the limits of potentially reactive material given in Table 3.2 are exceeded the aggregates may still be acceptable at the Engineer's sole discretion. To determine acceptability or otherwise of the aggregates the Engineers will require testing in accordance with ASTM C-289-87 and ASTM C-227-87 or as may be otherwise instructed.
- (iii) For protection of the structure by controlling the alkali content of the cement or concrete, the following clauses shall be complied with:
 - (a) The calculated alkali content of the concrete mix shall not exceed 4.0kg per cubic metre of concrete. If the assessment of the aggregate indicates that the only potentially reactive mineral or rock discovered is microcrystalline or cryptocrystalline quartz or chalcedony derived from chert which is of carboniferous age or older, the limit may be increased to 4.5 kg per cubic metre.

Or

- (b) The alkali content of the Portland cement shall not exceed 0.60%
- (c) The alkali content of the Portland cement shall be taken as the certified average acid soluble alkali content of the cement plus 1.64 standard deviations. The certified average acid soluble alkali content shall be the average of the last 25 determinations of alkali content carried out on consecutive daily samples immediately prior to submission. The Contractor shall submit to the Engineer the test certificates furnished by the cement manufacturer. The alkali content of the Portland cement shall be determined in accordance with the method

recommended in BS4550 Part 2 or by the use of an x-ray fluorescence technique calibrated against that Standard.



- (d) The Contractor shall submit to the Engineer test certificates giving the acid soluble alkali content of any slag or pulverized fuel ash to be used. These shall be determined using an approved method based on BS4550 Part 2.
- (e) The equivalent sodium oxide content of the coarse and fine aggregate shall be calculated from the quantity of chloride ion present, which shall be measured by the method in IS5 Part 3.8 Method of test for chloride salts.
- (f) For the purposes of 2.2.5 (iii) (a) the calculated alkali content of the concrete mix shall be determined by summing:
- The alkali content of the Portland cement.
 - 0.76 times the chloride ion content of the aggregates taken as the percentage by weight (ignore if C1 is less than 0.01%).
 - 50% of the acid soluble Na_2O equivalent of any slag taken as the certified average plus 1.64 standard deviations.
 - 17% of the acid soluble Na_2O equivalent of any PFA taken as the certified average plus 1.64 standard deviations.
 - The equivalent Na_2O contribution of any admixtures.

2.3 CONCRETE - REQUIREMENTS FOR DESIGNED MIXES:

2.3.1. Ready-Mixed Mixing:

All ready-mixed concrete shall comply with the provisions of I.S. EN 2000: Clause 7.3, 7.4 and 7.5 except where modified herein.

Where the Engineer is satisfied that a ready-mix concrete supplier has adequate quality control facilities combined with satisfactory test records to ensure the consistent production of the required grades of concrete specified, he will approve the production of concrete using the designed mixes as specified in Table 2.4. The minimum requirements for such approval are that the ready-mix plant shall comply with the requirements stipulated for an 'Approved Plant with Quality Control Procedures' in the Code for Ready-Mixed Concrete published by the Concrete Manufacturers Association of Ireland. Notwithstanding such approval, the Engineer will require test cubes to be made and tested in the manner already specified for prescribed mixes but the required margin between the characteristic and average test strengths shall be determined having due regard to the standard deviation appropriate to the ready-mix plant. Should the required test cube strengths not be achieved, the mix proportions shall be varied until the cube test and density criteria are achieved. The cost of these trial mixes excluding cube strength tests



shall be borne by the Contractor. The mix proportions, which have been finally determined as a result of the trial mixes, shall be used throughout the Contract unless there is a change in the quality of aggregates. Regular tests shall be carried out on the aggregates and if there is any material change in same mixes, they shall be redesigned but only subject to the Engineer's approval.

If the Engineer is not satisfied that the ready-mix plant complies with the requirements of the said Code, he will require concrete to be produced in accordance with the Prescribed Mixes Specification.

2.3.1. Suitability of Proposed Mix Proportions:

The Contractor shall submit for the Engineer's approval, prior to the supply of any designed mix, the following information:

- (i) The nature and source of each material
- (ii) Either (a) appropriate existing data as evidence of satisfactory previous performance for strength, workability and water/cement ratio or (b) full details of tests on trial mixes carried out in accordance with Clause 2.3.3. below.

2.3.2. Trial Mixes:

The Contractor shall give notice to enable the Engineer to be present at the making of trial mixes and preliminary testing of cubes. The Contractor shall prepare trial mixes, using samples of approved material typical of those he proposed to use in the works, for all grades, to the Engineer's satisfaction before commencement of concreting.

The water:cement ratio shall be kept to the minimum required to obtain a workable concrete. Batching of all materials shall be by weight unless special permission is granted by the Engineer for volume batching. Preliminary tests shall be carried out under supervision of the Engineer's Representative to determine optimum mix proportions after approval of which test cubes shall be made to ensure tabulated strength and density requirements are met. Cubes shall be made and tested in accordance with I.S. EN 12390: 2000 at 7 and 28 days or as directed by the Engineer.

2.3.3. Frequency of Concrete Testing.

Unless directed otherwise, the rate of sampling shall be the carried out as follows:

- a) One set of cubes per 5m^3 or 1 truck (Average capacity between 7 to 8m^3) on each day that concrete of that grade is used.
- b) Two sets of cubes per 20m^3 or 3 trucks on each day that concrete of



that grade used.

- c) Three sets of cubes per 50m³ or 7 trucks on each day that concrete of that grade is used.
- d) Four sets of cubes per 70m³ or 10 trucks on each day that concrete of that grade is used.
- e) For concrete pours greater than 70m³ the number of sets of concrete cubes to be taken shall be four per 70m³ unless otherwise agreed with the Engineer.

A set of cubes is deemed to include three specimens.

The first cube of each sample is to be tested in accordance with I.S. EN 12390: 2000: Part 3 to obtain the 7 day strength. The second cube is to be tested in accordance with I.S. EN 12390: 2000: Part 3 to obtain the 28 day strength. The remaining third cube is to be available for testing at any later or earlier time, at the discretion of the Engineer. Cube tests and sampling are to be carried out in accordance with I.S. EN 12390: 2000: Part 3.

Complete Correlated Records must be maintained for each mix type, including:

- a) Composition of the mixes tested, including any admixtures.
- b) -All sampling and site tests.
- c) -Identification marks or numbers of all specimens tested in the laboratory.
- d) -The location within the structure represented by each sample.

2.3.4. Additional Trial Mixes:

During production, the Contractor shall carry out trial mixes and tests, if required by the Engineer, before substantial changes are made in the materials or in the proportions of the materials to be used, except when adjustments to the mix proportions are carried out in accordance with Clause 2.4.2. below.

2.4 CONCRETE PRODUCTION:

2.4.1. Batching and Mixing:

The quantities of cement, fine aggregate and the various sizes of coarse aggregate shall be measured by weight unless otherwise agreed by the Engineer.

Separate weighing machines shall be used for cementitious materials and aggregates unless otherwise agreed by the Engineer. Alternatively, cementitious materials may be measured by using a whole number of bags in each mix.



The quantity of water adjusted for the free moisture content of the aggregate shall be measured. Any admixture to be added shall be measured and, if solid, shall be measured by weight. Different types of cement shall not be mixed.

The batch weight of aggregate shall be adjusted to allow for the free moisture content of the aggregate being used.

All measuring equipment shall be maintained in a clean and serviceable condition, its accuracy shall be checked over the range in use when set up at each site, and maintained thereafter.

The accuracy of equipment shall fall within the following limits:

Measurement of cementitious materials	$\pm 3\%$ of the quantity of cement in each batch
Measurement of water	$\pm 3\%$ of the quantity of water in each batch
Measurement of aggregate	$\pm 3\%$ of the total quantity of aggregate in each batch
Measurement of admixture	$\pm 5\%$ of the quantity of admixture in each batch

The mixer shall comply with BS 1305. Care shall be taken to ensure that all components are thoroughly mixed and in particular any admixtures are uniformly distributed throughout the batch.

The mixing time shall be not less than that recommended by the manufacturer.

Mixers that have been out of use for more than 30 minutes shall be thoroughly cleaned before any fresh concrete is mixed. Unless otherwise agreed by the Engineer, the first batch of concrete through the mixer shall then contain only two-thirds of the normal quantity of coarse aggregate. Mixing plants shall be thoroughly cleaned before changing from one type of cement to another.



2.4.2. Control of Strength of Designed Mixes:

Adjustments to mix proportions shall be made subject to the Engineer's approval, in order to minimise the variability of strength and to maintain the characteristic mean strength.

2.5 CONCRETE - COMPLIANCE:

2.5.1. General:

All sampling and testing of constituent materials shall be carried out in accordance with the appropriate Irish or British Standard. In particular, sampling and testing of fresh and of hardened concrete shall comply with BS 1881 unless this is at variance with this Specification. Cubes shall be made and tested in accordance with I.S. EN 12390: 2000 at 7 and 28 days or as directed by the Engineer.

2.5.2. Strength:

(i) General:

Compliance with the specified characteristic strength shall be based on tests made on cubes at an age of 28 days unless there is evidence, satisfactory to the Engineer, that a particular testing regime is capable of predicting the strength at 28 days of concrete tested at an earlier age. Unless otherwise directed by the Engineer, the rate of sampling shall be as given in Table 3.3 but not less than one sample shall be taken on each day that concrete of that grade is used.

Table 3.3 Rates of Sampling and Testing

Grade of Concrete	Size of Pour	Sample from one batch selected randomly to represent an average volume of not more than the lesser of
Greater than 40N/mm ²	Any size	10m ³ or 10 batches
30-40 N/mm ³	Less than 20m ³	10m ³ or 10 batches
	20-75 m ³	15m ³ or 15 batches
	Greater than 75m ³	20m ³ or 20 batches
Less than 30N/mm ²	Any size	20m ³ or 20 batches

(ii) Testing:

One cube shall be made from a sample taken from a randomly selected batch of concrete. Samples shall be taken at the point of discharge from the delivery vehicle.



Compliance with the characteristic strength shall be assumed if the conditions given in both (a) and (b) are met.

- (a) The average strength determined from any group of four consecutive test results exceeds the specified characteristic strength by 3 N/mm^2 for concrete of grade 20 and above. 2 N/mm^2 for concretes of grade 7.5 to 15.
- (b) The strength determined from any test result is not less than the specified characteristic strength minus 3 N/mm^2 for concretes of grade 20 and above. 2 N/mm^2 for concretes of grade 7.5 to 15.

If only one cube result fails to meet the second requirement (b), then that result shall be considered to represent only the particular batch of concrete from which that cube was taken.

If the average strength of any group of four consecutive test cubes fails to meet the first requirement (a), then all the concrete in all the batches represented by all such cubes shall be deemed not to comply with the strength requirements. For the purpose of this clause the batches of concrete represented by a group of four consecutive test cubes shall include the batches from which samples were taken to make the first and the last cubes in the group of four, together with all the intervening batches.

BROKEN CUBES: Keep separately the pieces of each cube which fails to meet the compliance requirements for individual results. Obtain agreement of Engineer before discarding.

EARLY AGE STRENGTH TESTING: A regime of accelerated or normal curing and early testing which is capable of predicting the 28 day strength of Designed mixes may be used for determining compliance, subject to prior approval. If such a regime is adopted, two additional cubes must be made from each sample and cured normally so that, in the event of noncompliance, they can be tested at 28 days to provide information which will help in deciding the action to be taken.

FAILURES: If a concrete sample fails to achieve specified criteria or to pass specified tests, inform the Engineer without delay and submit:

- Confirmation of the validity of the test results, and/or
- Proposals for further tests to assess the strength of the concrete in the structure, as set out in BS 6089, and/or
- Proposals for rectification.

Obtain approval of such evidence and proposals before proceeding. The Engineer may issue instructions for the work to be stopped or delayed until reasons for the failure have been established, possible consequences assessed, and appropriate preventative and remedial measures taken.

Wherever the specified sampling, testing and compliance procedures show that a concrete mix is not in accordance with the specification (even if the work is eventually accepted), and measures are taken to help in establishing whether or not the work is acceptable, such measures:



- Will be at the expense of the Contractor, and
- Will not be considered as grounds for extension of time.

(iii) Special Testing:

Special testing shall be used if required in the Contract:

One test cube shall be made from each of two independent representative samples taken from every batch of concrete selected for testing.

The average strength of the two test cubes taken from the same batch of concrete shall exceed the specified characteristic strength by not less than 2.0N/mm^2 or one-tenth of the specified strength, whichever is the smaller.

If the average strength of the test specimens taken to represent a given batch of concrete fails to meet the appropriate requirement, the whole of that batch of concrete represented by those specimens shall be deemed not to comply with the strength requirements of the Specification. Compliance with this requirement in respect of a given batch of concrete shall not be adduced as evidence of compliance in respect of any other batch.

2.5.3. Workability:

The workability of the fresh concrete shall be such that the concrete is suitable for the conditions of handling and placing as described in Clause 2.6.1. so that after compaction as described in Clause 2.6.6., it surrounds all reinforcement, tendons and ducts and completely fills the formwork. Workability shall be measured for each batch or at such times as directed by the Engineer using tests in accordance with Clause 3.5 of BS 5328 Part 4. The workability shall be within the limits of the required value given in clause 3.5 of BS 5328 Part 4.

2.5.4. Test Results:

Results of test on concrete samples shall be forwarded directly to the Engineer.

2.6 CONCRETE - CONSTRUCTION GENERAL:

2.6.1. Construction Joints:

Construction or day joints shall be formed in the following positions, unless otherwise shown on the drawings or agreed with the Engineer:

Beams - Middle of the span.

Suspended Slabs - Middle of the span, parallel to or at right angles to the main reinforcement.

Columns - 50mm below the junction of the vertical member and the soffit of beam, haunch or slab, and at positions defined by kickers where used.

When concrete is placed in vertical members, walls, columns and the like, the lifts of concrete shall finish level or, in sloping members, at right angles to the axis of the members, and the joint lines shall match features of the finished work, if possible, or be



formed by grout checks. Kickers if required shall be constructed integrally with the lift of concrete below. They shall be at least 100mm high and they shall be provided in all locations shown on the drawings and at all locations where in the Engineer's opinion the specified quality of concrete or finish requires their use.

Concreting shall be carried out continuously up to construction joints. When the concrete is self-supporting but still sufficiently green the formwork shall be removed, as necessary, to expose the construction joint, subject to Clause 2.6.10. The concrete surface shall be sprayed with a fine spray of water or brushed with a stiff brush, just sufficiently to remove the outer mortar skin and expose the larger aggregate without disturbing it. Alternatively, where this preparation proves impracticable the hardened surface skin and laitance shall be removed by sand blasting or a needle gun. Hardened surfaces shall not be hacked. Formwork retarding agents shall not be used unless authorised by the Engineer. Immediately before fresh concrete is placed against the joint, the joint surface shall be cleaned, dampened and coated with a neat cement/water slurry, the surface shall be free of standing water.

Construction, expansion and isolation joints to be constructed as detailed on drawings. Inform Engineer prior to concrete pours, in order that reinforcement may be inspected.

2.6.2. Inserts, Holes and Chases:

The Contractor shall fix or box out for inserts in accordance with the drawings or as instructed, prior to placing the concrete.

The Contractor shall form holes and chases in accordance with the drawings or as instructed, prior to placing the concrete.

Cast concrete shall not be cut without instructions.

2.6.3. Formwork:

The design, erection, and removal of formwork shall be the responsibility of the Contractor.

The formwork shall be designed and constructed to produce concrete to the tolerances, levels and finishes specified and to withstand the worst combination of:

- (i) Total weight of formwork, reinforcement, and concrete.
- (ii) Hydrostatic pressure of plastic concrete.
- (iii) Construction loads, including static and dynamic effects of placing, compacting and construction traffic.
- (iv) Wind and snow loads.

The formwork shall be sufficiently rigid and tight to prevent loss of grout or mortar from the concrete at all stages and for the appropriate method of placing and compacting.

The formwork shall be so arranged as to be readily dismantled and removed from the cast concrete without shock, disturbance or damage.



Formwork shall be carried down to a foundation or such other construction that is sufficiently strong to provide effective support without causing excessive stress or movement in that foundation or construction.

Where it is intended to re-use formwork, it shall be thoroughly cleaned and made good to the satisfaction of the Engineer.

No metal part of any device for locating formwork shall remain within concrete provided as cover to the reinforcement.

Immediately before concreting, all forms shall be thoroughly cleaned out.

Where holes are needed in forms to accommodate projecting reinforcement or fixing devices, care shall be taken to prevent loss of grout when concreting or damage when striking forms.

2.6.4. Control:

The design, detailing, construction and use of Temporary Works is the sole responsibility of the Contractor, he shall take into account the recommendations of BS 5975 Code of Practice for Falsework as well as 'Formwork' - a joint report of the Concrete Society and the Institution of Structural Engineers 1986. All design and detailing of temporary works shall be carried out under the control of a competent Temporary Works Designer and construction and use shall be under the direct control of a competent Falsework Co-ordinator. The Contractor shall submit details of his proposals for the design, detailing, construction and use of all temporary works to the Engineer well in advance of commencement of Temporary Works.

2.6.5. Tolerances for Finished Work:

(i) **Accuracy:**

Construct formwork accurately and robustly with adequate supports to produce finished concrete to the required dimensions. Formed surfaces must be free from twist and bow (other than any required cambers), all intersections, lines and angles being square, plumb and true.

(ii) **Level:**

For any nominally horizontal surface, excluding ground floor slab, when measured from the nearest reference level; the permissible deviation shall be ± 10 mm.

(iii) **Level of Finished Surface:**

SURFACE REGULARITY OF CONCRETE STRUCTURAL FLOORS:
Sudden irregularities not permitted. When measured with a slip gauge to BS 8204: Part 1 or 2, Figure 3 or equivalent, the variation in gap under a straightedge (with feet) placed anywhere on the surface to be not more than the following:



- Floors which are to be self-finished, and floors to receive sheet or tile finishes directly bedded in adhesive:
5mm under a 3m straightedge;

2mm under a 1m straightedge.
- Floors to receive screeds/toppings/beds up to 50mm thick:
10mm under a 3m straightedge.
- Floors to receive mastic asphalt flooring or underlay laid over mastic asphalt levelling coat(s): 10mm under a 3m straightedge.

2.6.6. General Requirements:

Concrete shall not be pumped or discharged through items containing aluminium alloys. Concreting operations shall not be permitted to displace reinforcement, to damage the faces of formwork. Competent steel fixers and formwork carpenters shall be in constant attendance during concreting operations.

Concrete shall be thoroughly compacted by vibration, unless otherwise agreed by the Engineer, during the operation of placing, and thoroughly worked around the reinforcement, around embedded fixtures and into corners of the formwork to form a solid mass free from voids. When vibrators are used to compact the concrete, vibration shall be applied continuously during the placing of each batch of concrete until the expulsion of air has practically ceased and in a manner that does not promote segregation of the ingredients.

All necessary compaction shall be completed within 30 minutes of discharge from the mixer or agitator.

Vibration shall not be applied by way of the reinforcement. Where vibrators of the immersion type are used, contact with reinforcement and all inserts shall be avoided as far as is practicable. Concrete shall not be subjected to disturbance between 4 hours and 24 hours after compaction except with the agreement of the Engineer. Whenever vibration has to be applied externally, the design of formwork and disposition of vibrators shall ensure efficient compaction and the avoidance of surface blemishes.

VIBRATORS: Inform Engineer of the number and type of vibrators to be used. Provide standby vibrators. Do not use external vibrators without approval.

PLASTIC SETTLEMENT: At the top of deep sections and at significant changes in the depth of concrete sections, closely and continuously inspect the fresh concrete for signs of settlement during the first few hours after placing. While the concrete is still capable of being fluidized by the vibrator, revibrate as necessary to remove settlement cracking which may be forming either on the top surface or against the upper part of the vertical formwork.

2.6.7. Striking of Formwork:

Strike all formwork other than permanent forms without disturbing, damaging or overloading the concrete structure.



The stability of the structure and the protection of the concrete after striking the formwork shall remain the responsibility of the Contractor.

The minimum period for retaining formwork in position before striking shall not be less than indicated in the following table.

Type of Formwork	Cement Type			
	Normal Portland Cement		Rapid Hardening Portland Cement	
	Mean Air Shade Temperature		Mean Air Shade Temperature	
	7°C	16°C	7°C	16°C
Vertical facing to columns, walls and beams	12 hrs	12 hrs	12 hrs	12 hrs
Soffit facing to slabs	5 days	3 days	4 days	2 days
Support to slabs	12 days	10 days	10 days	8 days
Soffit facing to beams	5 days	3 days	4 days	2 days
Support to beams	18 days	15 days	15 days	12 days

Periods during which the air shade temperature remain below 3°C shall not be taken into account. Provided always that the minimal periods before striking are as in the above table, the actual times of striking shall remain the responsibility of the Contractor.

Where the Contractor can submit evidence that the performance of the structure will not be adversely affected by reducing the specified periods before striking, reduced striking times may be approved.

Re-propping shall not be permitted unless approval is obtained



2.6.8. Curing of Concrete:

Immediately after compaction and thereafter for seven days, concrete shall be protected against harmful effects of weather, including rain, rapid temperature changes, frost, and from drying out. The method of curing shall prevent loss of moisture from the concrete.

Details of all curing liquids, compounds, membranes and methods to be used, and subsequent removal where necessary, shall be subject to the approval of the Engineer.

CURING PERIODS: in days (t =the average number of degrees centigrade air temperature during the curing period):

Concrete surfaces which in the finished building will be exposed to the elements; concrete wearing surface floors and pavements; watertight concrete:

	Concrete made Using OPC	Concrete made using PPFAC, PBFC, HSBC, pfa, ggbs
Drying winds or dry, sunny weather	$\frac{140}{t+10}$	$\frac{180}{t+10}$
Intermediate conditions	$\frac{100}{t+10}$	$\frac{140}{t+10}$
Damp wather, protected from sun and wind	$\frac{100}{t+10}$	$\frac{100}{t+10}$

• Other structural concrete surfaces (cements as above):

Drying winds or dry, sunny weather	$\frac{80}{t+10}$	$\frac{140}{t+10}$
Intermediate conditions	$\frac{60}{t+10}$	$\frac{80}{t+10}$
Damp weather, protected from sun and wind	No special requirements	No special requirements

Obtain prior approval for curing periods for mixes using admixtures or other types of cement.

CURING PERIODS: not less than:

- Surfaces which in the finished building will be exposed to the elements, and wearing surfaces of floors and pavements, regardless of weather conditions - 10 days
- Other structural concrete surfaces - 5 days



PROTECTION: Prevent damage to concrete, including:

- Surfaces generally: From rain, indentation and other physical damage.
- Surfaces to be exposed in the finished work: From dirt, staining, rust marks and other disfiguration.
- Immature concrete: From thermal shock, physical shock, overloading, movement and vibration.
- In cold weather: From entrapment of water in pockets, etc. and freezing expansion thereof.
- Concrete surfaces which in the finished building will be exposed to the elements; concrete wearing surface floors and pavements; watertight concrete:

	Concrete made Using OPC	Concrete made using PPFAC, PBFC, HSBC, pfa, ggbs
November to April	10	12
May to October	7	10

- Other structural concrete surfaces: No special requirements if in damp weather and protected from sun and wind, otherwise as follows (cements as above):

November to April	6	10
May to October	4	7

- Obtain prior approval for curing periods for mixes using admixtures or other types of cement.

2.6.9 Cold Weather Work:

Concrete shall not be placed while the air temperature is below 2°C measured on a rising thermometer or below 4°C measured on a falling thermometer, unless the following requirements are met:

- (i) The aggregates and water used in the mix shall be free from snow, ice, and rost.
- (ii) The surface temperature of the concrete at the time of placing shall be at least 5°C and shall not exceed 30°C.
- (ii) The surface temperature of the concrete shall be maintained at not less than 5°C until the concrete reaches a strength of 5N/mm² as determined by tests on cubes that were cured under identical conditions to the structural concrete, in a manner approved by the Engineer.



- (iv) Before placing concrete, the formwork, reinforcement and any surface with which the fresh concrete shall be in contact shall be free from snow, ice and frost.
- (v) Cement shall not be allowed to come into contact with water at a temperature greater than 60°C.

2.6.10. Hot Weather Work:

During hot weather, the Contractor shall ensure that the constituent materials of the concrete are sufficiently cool to prevent the concrete from stiffening in the interval between its discharge from the mixer and compaction in its final position.

Cement shall not be allowed to come into contact with water at a temperature greater than 60°C.

2.6.11. Formed Finishes / Type of Surface Finish:

Type A, Type B and Type C surface finishes shall comply with EN 1992-1-1:2004.

Type A finish is obtained by the use of properly designed formwork or moulds of timber, plywood, plastics, concrete or steel. Small blemishes caused by entrapped air or water may be expected but the surface shall be free from voids, honeycombing and other blemishes.

Type B finish can only be obtained by the use of high quality concrete and formwork. The concrete shall be thoroughly compacted and all surfaces shall be true, with clean arises. Only very minor surface blemishes shall be accepted, with no staining or discolouration from the release agent acceptable.

Type C finish is obtained by first producing a Type B finish. The surface is then improved by carefully removing all fins and other projections, thoroughly washing down, and then filling the most noticeable surface blemishes with a cement and fine aggregate paste to match the colour of the original concrete. The release agent shall be carefully chosen to ensure that the concrete surface will not be stained or discoloured. After the concrete has been properly cured, the face shall be rubbed down, where necessary, to produce a smooth and even surface.

FINISH TO RECEIVE ASPHALT TANKING:

- Produce an even finish with a sheet material (e.g. plywood), suitable to receive asphalt, and acceptable to asphalt contractor.
- Avoid excessive use of release agents.
- Abrupt irregularities to be not greater than 3 mm. Gradual irregularities, expressed as a maximum permissible deviation from a 1m straight edge, to be not greater than 3 mm.
- Blowholes less than 10 mm in diameter will be permitted but otherwise surface to be free from voids, honeycombing, segregation and other large defects.
- Making good: Projecting fins are to be removed and rubbed down with a carborundum stone but otherwise the finish is to be left as struck.

Making good of small defects will normally be permitted after inspection by



Engineer.

- Arrises to be chamfered with a 30 mm wide corner face.
- Formwork tie holes to be filled with mortar.

PLAIN SMOOTH FINISH:

- Produce an even finish with a sheet material (e.g. plywood), with panels arranged in a regular pattern as a feature of the surface.
- Abrupt irregularities to be not greater than 5 mm. Gradual irregularities, expressed as maximum permissible deviation from a 1m straight edge, to be not greater than 5mm.
- Variation in colour resulting from the use of an impermeable form lining will be permitted but the surface to be free from discolouration due to contamination or grout leakage.
- Blowholes less than 10 mm in diameter will be permitted but otherwise surface to be free from voids, honeycombing, segregation and other large defects.
- Make good: Projecting fins are to be removed and rubbed down with a carborundum stone but otherwise the finish is to be left as struck. Making good of small defects will normally be permitted after inspection by Engineer.
- Arrises to be chamfered with a 30 mm wide corner face. Refer to a drawing if necessary.
- Formwork tie holes to be in an approved regular pattern, filled with matching mortar to an approved sample.
- Complete a sample area of the finished work, size 9 sq m, in advance of the remainder, in an approved location, and obtain approval of appearance before proceeding.

FINE SMOOTH FINISH:

- Produce a smooth even finish with an impervious sheet material (e.g. resin film faced plywood), with panels as large as is practicable and arranged in an approved regular pattern as a feature of the surface. Do not replace parts of formwork panels where this may cause a change of colour in the concrete.
- Abrupt irregularities to be not greater than 3 mm. Gradual irregularities, expressed as maximum permissible deviation from a 1 m straight edge, to be not greater than 3 mm.
- Variation in colour resulting from the use of an impermeable form lining will be permitted but the surface is to be free from discolouration due to contamination or grout leakage.
- Cover spacers: Do not use without approval.
- Blowholes less than 5 mm in diameter will be permitted but otherwise surface to be free from voids, honeycombing, segregation and other defects.
- Making good: Projecting fins are to be removed and rubbed down with a carborundum stone but otherwise the finish is to be left as struck. Making good will not normally be permitted.
- Arrises to be – refer to drawing if necessary.
- Formwork tie holes to be in an approved regular pattern, filled with matching mortar to an approved sample.
- Complete a sample area of the finished work, size 9 sq m, in advance of the remainder, in an approved location, and obtain approval of appearance before proceeding.



FINISH FOR ABRASIVE BLASTING:

- Produce an even finish with a sheet material (e.g. plywood), with accurate, true and even joints masked on the face with pressure-sensitive tape such that they will be indistinguishable after blasting.
- Gradual irregularities, expressed as maximum permissible deviation from a 1m straight edge, to be not greater than 3 mm.
- Do not use cover spacers.
- Blowholes less than 10 mm in diameter will be permitted but otherwise surface to be free from voids, honeycombing, segregation and other large defects.
- Arrises to be as described on drawings.
- Formwork tie holes to be in an approved regular pattern, filled with matching mortar to an approved sample.

FINISH FOR TOOLING:

- Produce an even finish with a sheet material (e.g. plywood), with accurate, true and even joints masked on the face with pressure-sensitive tape such that they will be indistinguishable after tooling.
- Gradual irregularities, expressed as maximum permissible deviation from a 1 m straight edge, to be not greater than 5 mm.
- Do not cover spacers.
- Blowholes less than 10 mm in diameter will be permitted but otherwise surface to be free from voids, honeycombing, segregation and other large defects.
- Arrises to be as described on drawings.
- Formwork tie holes to be in an approved regular pattern, filled with matching mortar to an approved sample.

FINISH FOR TOOLING:

- Produce an even finish with a sheet material (e.g. plywood), with accurate, true and even joints masked on the face with pressure-sensitive tape such that they will be indistinguishable after tooling.
- Gradual irregularities, expressed as maximum permissible deviation from a 1 m straight edge, to be not greater than 5 mm.
- Do not cover spacers.
- Blowholes less than 10 mm in diameter will be permitted but otherwise surface to be free from voids, honeycombing, segregation and other large defects.
- Arrises to be as described on drawings.
- Formwork tie holes to be in an approved regular pattern, filled with matching mortar to an approved sample.



2.7 REINFORCEMENT:

2.7.1. Materials:

Plain Bar Reinforcement to BS 4449 Grade 250.

Deformed Bar Reinforcement to BS4449 Grade 500B

Steel fabric reinforcement shall comply with BS 4483 and shall be delivered to the site in flat mats.

The classification of deformed bars as type (1) or (2) for bond strength shall be in accordance with Appendix B of BS 4461.

2.7.2. Bar Schedule Dimensions: Cutting and Bending:

The requirements of BS 8666 shall be complied with. The Bar Schedules are based on the dimensions of the concrete and the nominal cover to the reinforcement described in the Contract. The reinforcement shall be cut and bent within the tolerances given in BS 8666 but this shall not relieve the Contractor of his responsibility for the correct fit of the reinforcement and the achievement of the required cover.

Bending at temperatures below 5°C or in excess of 100°C may only be carried out with the Engineer's approval and under his supervision. Any reinforcement bar that has already

been bent shall not be rebent at the location of the original bend without the Engineer's permission.

2.7.3. Fixing:

Reinforcement shall be secured against displacement. Unless specified otherwise, the actual concrete cover shall be not less than the required nominal cover, minus 5mm.

The cover to a bar in an outer layer of reinforcement shall not exceed the nominal cover described in the Contract by more than 4% of the overall dimension of the member, measured in the same direction, or by more than 20mm, whichever is the lesser. Bars in inner layers shall be located as described in the Contract: they shall be in close contact with the bars of the outer layer, unless otherwise indicated.

Cover blocks shall be of comparable strength, durability and appearance to the surrounding concrete. They shall match the mix proportions of the adjacent material so far as is practicable. They shall ensure that the reinforcement is correctly positioned and shall be as small as possible consistent with their purpose, of a shape acceptable to the Engineer and designed so that they will not overturn or be displaced when the concrete is placed.

Wire cast in the block for the purpose of tying it to the reinforcement shall be as described below. Stainless steel tying wire shall be used in cover blocks to exposed surfaces.

Other types of cover blocks may be used only with the approval of the Engineer. Pieces of wood, metal, tile or porous material shall not be used as cover blocks.

Projecting ends of ties or clips shall not encroach into the concrete cover. Tying wires shall be either -



- (i) 1.6 mm diameter soft annealed iron wire for unexposed surfaces, or
- (ii) 1.2 mm diameter stainless steel wire for exposed surfaces and when required in the Contract.

2.7.4. Surface Condition:

Immediately before concrete is placed around it, reinforcement shall be clean, free from mud, oil, paint, retarder, release agent, loose rust, loose mill scale, snow, ice, grease or any other substance that can be shown to affect adversely the steel or concrete chemically, or to reduce the bond.

Prevent rust staining of surfaces of concrete which will be exposed to view in the finished work, caused by, e.g. rust stained formwork or unprotected projecting reinforcement.

Store reinforcement clear of the ground and prevent contamination by other materials. At the time of placing concrete, reinforcement is to be clean and free of corrosive pitting, loose millscale, loose rust, ice, oil and other substances which may adversely affect the reinforcement, concrete or bond between the two.

2.7.5. Checking Cover:

For use where checking by the Engineer is considered necessary and they do not otherwise have a meter for a period(s) of 2 days, as and when instructed, provide and maintain fully charged, for the sole use of the Engineer, an approved magnetic induction digital display type cover meter calibrated in accordance with manufacturer's recommendations.

2.7.6. Laps and Joints:

Laps and joints including sleeving, threading and other mechanical connections shall be made only as described in the Contract or as agreed by the Engineer.

2.7.7. Joints:

ACCURACY: All joints to be accurately located, straight and well-aligned, and truly vertical or horizontal or parallel with the setting out lines of the building.

CONSTRUCTION/MOVEMENT JOINTS:

- Form joints accurately to detail and in locations shown on the drawings.
 - If modifications to any joint design or location are necessary on site, agree revisions with Engineer before proceeding.
 - Do not allow concrete to enter any gaps or voids in the formwork or to render the movement joints ineffective.
 - Do not allow concrete to impregnate any materials used as compressible joint fillers.
- Do not place concrete simultaneously on both sides of movement joints.

CONSTRUCTION JOINTS IN CONCRETE EXPOSED TO VIEW:

- Additional to joints required by the designer, will not be permitted.

CONSTRUCTION JOINTS IN CONCRETE WEARING SURFACE FLOORS:

- Additional to joints required by the designer, will normally be permitted, but with agreement of the Engineers.



- If such additional joints are required, allow accordingly in the rates. Obtain approval of proposed locations.

FORMED JOINTS:

- Construct using rigid, grout-tight side forms or stop ends designed to accommodate projecting bars or fabric without temporary bending or displacement.

FORMED JOINTS: In concrete wearing surface floors:

- Forms to be square edged with a steel top surface and in good condition.
- Compact thoroughly at edges to give level, closely abutted joints with no lipping.

ROUGHENING OF CONSTRUCTION JOINT FACES: Brush and spray surface of construction joints while concrete is still green to leave a thoroughly roughened exposed aggregate finish.

TIE BARS:

- To BS 4449, Grade 250, clean and free from loose millscale, loose rust, ice, oil and other deleterious substances.
- Fix securely at the stated centres, at the required depth, and centred on the joints.

MESH TIE STRIPS:

- To BS 4483, clean and free from loose millscale, loose rust, ice, oil and other deleterious substances.
- Fix securely at the required depth with the width of the mesh strip centred on the joint.

DOWEL BARS:

- To BS 4449, Grade 250, perfectly straight, with sawn (not sheared) ends.
- Coat half of each bar with a suitable proprietary debonding compound or fit with a suitable plastics sleeve.
- Fix bars securely at the required depth, perfectly level, at right angles to and centred on the joint.
- At expansion joints fit an approved type of cap incorporating not less than 20 mm of compressible material to debonded ends of all bars.

SHEET JOINT FILLER for expansion joints:

- Manufacturer and reference: as approved.
- Fix accurately in position. Ensure that sufficient space is left for sealant by using temporary formers.

2.8 WORKED FINISHES TO IN SITU CONCRETE:

TIMING: Carry out all finishing operations at optimum times in relation to the setting and hardening of the concrete. Do not wet surfaces of concrete to assist surface working. Do not sprinkle cement on to surface.

TAMPED FINISH: Tamp surface with edge of a board or beam to give an even texture of parallel ribs.

SCORED FINISH:

Scratch surface with a stiff brush to give a roughened texture.

BRUSHED FINISH TO RECEIVE mastic asphalt flooring:



Brush surface with a stiff broom or wire brush while still green, to produce a lightly textured surface.

SMOOTH FLOATED FINISH:

Use a hand float, skip float or power float to give an even surface with no ridges or steps.

TROWELLED FINISH for wearing surfaces:

- Float concrete to an even surface with no ridges or steps, then immediately commence curing as specified.
- Successively hand or power trowel at intervals, apply sufficient pressure to close the surface, to give a uniform smooth finish free from trowel marks and other blemishes.
- Resume specified curing without delay.
- Complete a sample area of the finished work, size 9 sq m, in advance of the remainder, in an approved location, and obtain approval of appearance before proceeding.

DEWATERED TROWELLED FINISH for wearing surfaces:

- Immediately after compaction of the concrete, apply the vacuum dewatering process in accordance with the equipment manufacturer's recommendations.
- Without delay, float the surface using a power float to give an even surface with no ridges or steps, then immediately commence curing as specified.
- Successively hand or power trowel at intervals, applying sufficient pressure to close the surface, to give a uniform smooth finish free from trowel marks and other blemishes.
- Resume specified curing without delay.
- Complete a sample area of the finished work, size 9 sq m, in advance of the remainder, in an approved location, and obtain approval of appearance before proceeding.

NONSLIP TROWELLED FINISH for wearing surfaces:

- Float to an even surface with no ridges or steps, then immediately commence curing.
- Successively hand or power trowel at intervals, applying sufficient pressure to close the surface, to give a uniform smooth finish free from trowel marks and other blemishes.
- Apply silicon carbide or aluminium oxide, graded between BS 410 sieves 1.7 mm and 500 microns, sprinkling evenly at the rate of 1 kg/sq m and trowel into the surface while the concrete is still plastic.
- Resume specified curing without delay.
- Complete a sample area of the finished work, size 9 sq m, in advance of the remainder, in an approved location, and obtain approval of appearance before proceeding.

POWER GROUND FINISH for wearing surfaces:

- Float to an even surface with no ridges or steps, then immediately commence curing.
- When concrete is sufficiently hard for sand particles not to be torn from the surface, power grind to remove 1-2 mm from surface to give an even glass-paper texture, free from blemishes and trowel marks.
- Remove all dust and wash down. Resume specified curing without delay.



- Complete a sample area of the finished work, size 9 sq m, in advance of the remainder, in an approved location, and obtain approval of appearance before proceeding.

3.0 STRUCTURAL STEELWORK:

3.1 Materials:

3.1.1. Sections and Plates:

The dimensions and tolerances of hot rolled steel sections including hollow sections, shall comply with BS 4 Parts 1 and 2 and BS EN 10210: Part 2. All steel shown on drawings is hot finished unless otherwise shown.

Hot rolled steel plates and sections, including hollow sections, shall comply with BS.4360 or EN 1993 or equivalent.

Use the following grade of steel unless indicated otherwise on the drawings: BS 4360, Grade 43 or to EN 1993:2005.

The dimensions and tolerances of cold formed steel sections shall comply with BS.2994 or equivalent or to EN 10162:2003.

The material for cold formed steel sections shall comply with BS.1449, Part 1 or equivalent.

The material for cold formed galvanized purlins and rails shall comply with EN 1993 and shall have a minimum yield stress of 350N/mm²

All steel shall be free from pitting and other surfaces flaws that are likely to impair the specified finish.

Galvanised structural steel, specified for galvanising, in accordance with BS729 and BS EN ISO 1461:2009 with a minimum coating weight of 700 g/m².

All steelwork to be Execution Class 2 in accordance with I.S. EN1090-2 with CE Marking.

3.1.2. Welding Materials:

Welding electrodes for manual metal arc welding shall comply with BS639 or BS EN ISO 2560:2009 or equivalent.

Electrodes, wires and fluxes for the submerged arc welding of carbon steel and medium-tensile steel shall comply with BS4165 or BS EN ISO 14171:2010 & EN 760:1996 or equivalent.

Filler rods and wires for gas-shielded arc welding shall comply with BS2901, Part 1 or BS EN ISO 14341:2008 & EN ISO 636:2008 or equivalent.

3.1.3. Fasteners:

Black hexagon bolts, screws and nuts shall comply with BS4190 or equivalent.

Precision hexagon bolts, screws and nuts shall comply with BS3692 or equivalent.

Use expanding bolts and nuts as specified by the Engineer.



Chemical Anchors or Stud anchors to be galvanised unless noted otherwise. Chemical to be injected polyester resin by approved manufacturer to the prior approval of the Architect. Anchors shall be installed strictly in accordance with the manufacturer's instructions.

Steel washers shall comply with BS 4320 or equivalent.

High strength friction grip bolts and associated nuts and washers shall comply with BS4395, Parts 1 and 2.

Indented bolts and nuts shall comply with BS 1494 Parts 2, or equivalent.

3.2 WORKMANSHIP:

3.2.1. Design and Construction Generally:

The fabrication and erection of the structural steel shall be carried out by an approved firm or firms.

Submit the values of slip factors used for the design of all HSFG bolted joints.

Submit details of the following at least three weeks before the commencement of the steelwork erection:

1. Method of Erection,
2. Temporary Works.

Submit details of the erection programme at least three weeks before commencement of work.

3.2.2. Tolerances:

The permissible dimensional deviations for structural steel elements above foundations shall be as follows:

For any nominally horizontal surface, measured from the nearest reference level: ± 10 mm.

For any nominally vertical surface, measured from the nearest reference line: ± 10 mm. Notwithstanding the tolerances permitted above, the following shall apply.

Cross sections of built-up members: The permissible deviation of cross-sectional dimensions of built up members from that shown on the drawings shall be ± 3 mm unless otherwise indicated on the drawings.

Plumbness: The permissible deviation in plumbness of elements shall be 1:500.

Bow: The permissible deviation in bow shall be 1/1000 of the length of the members.

The maximum permissible overall deviations for horizontal and vertical dimensions shall not exceed ± 30 mm or 1 : 1000 whichever is the smaller.

3.2.3. Quality Control:



Arrange for any tests which may be required to be carried out by an approved authority or firm in accordance with Provisional Sum.

Arrange that the testing authority or firm shall furnish copies of the test results directly to the Structural Engineer.

Provide manufacturer's test certificates as requested.

Provide the necessary facilities and attendances for specified tests in workshops and on site.

The material tests specified shall be carried out in accordance with BS4360 or equivalent.

Radiographic or ultrasonic examination of welds may be required and shall be carried out in accordance with BS2600 Part 1 and BS 3923 respectively.

3.2.4. Prefabrication:

Fabricate all structural steel in accordance with EN1993 unless specified otherwise.

Machine ends of compression members at splices, caps or bases dependent on contact for transmission of compressive stress so that the butting faces are in contact except for small areas, which shall not exceed 20% of the total area, where the clearances do not exceed 0.15 mm.

Cut and grind bearing stiffeners to ensure a tight fit along edges in contact with flanges.

Fix cleats to project 2 mm beyond the end of simply supported members.

Remove all burrs and sharp arrises.

Do not form splices other than those shown on drawings.

Mark distinctly each piece of steelwork in accordance with an assembly drawing before delivery to site.

Use a contrasting and compatible paint to mark steel which is given anti- corrosion treatment before delivery to site.

Mark steel by hard stamping or by other approved methods as shown on the drawings. Ensure adequate depth of stamping to prevent obliteration.

All steelwork to be fixed to foundations with cast in holding down bolts. No post-drilling is allowed unless specified on the drawings.

All steelwork to be CE Certified to Execution Class 2 in accordance with EN1090.

3.2.5. Site Erection Generally:

Not less than 7 days before proposed start date, check foundations and other structures to which steelwork will be attached for accuracy of setting out, and holding down bolts for position, protruding length, condition and slackness. Report any inaccuracies and defects to the Main Contractor and the Architect without delay.



Obtain permission of Architect to commence erection.

Erect all structural steelwork in accordance with EN 1993.

Do not exceed the limiting stresses specified in EN 1993 during erection.

Steel packs under base plates shall not be less than 50 mm wide and each pack shall comprise not more than four separate plates.

3.2.5.1 Erecting Steelwork:

Provide all temporary erection bracing necessary to ensure stability of the structure during erection.

Do not distort steelwork and do not exceed stress limits specified in EN1993 during erection.

3.2.5.2 Column Bases:

Raise or lower to correct level using sawn steel packs or folding wedges not larger than necessary for the purpose. Position packs symmetrically around perimeter of base; do not use a single central pack and ensure each pack comprises not more than four separate plates.

Notify the Architect when the space beneath any column base is less than 15 mm or more than 80 mm.

Check accuracy of erection and correct all errors before grouting/casting in bases and carrying out any other adjacent work. Completely fill bolt pockets and space beneath column base plates with grout or mortar as specified on the drawings

3.2.6. Flame Cutting and Welding:

Flame cut by machine. Flame-cut edges which will be subjected to substantial stress or which are to have weld metal deposited on them shall be reasonably free from gouges. Occasional notches or gouges not more than 3 mm deep shall be permitted. Gouge marks greater than 3 mm that remain from cutting shall be removed by grinding. Shape all re-entrant corners to a radius of at least 15 mm.

Do not use flame cutting equipment on site without approval.

Welding shall be a metal arc process in accordance with BS5135 and BS4570 as appropriate, unless specifically permitted by the Engineer.

Written welding procedures shall be prepared and tested in accordance with BS 4870, Part 1, by the Steelwork Contractor.

The procedure shall identify material, weld geometry, tolerances, welding process, preheat temperature and welding position to be used.

Welding electrodes for manual metal arc welding shall comply with BS 639 or equivalent.

The welding of steel, including tack welds to be incorporated in the finished work, shall comply with the following schedule.



Material Specification	Grade of Steel	Welding Specification
BS 5950 Parts 1 & 2	S275	BS EN 101: Parts 1 & 2

The length of tack welds which shall be incorporated in the finished work shall not be less than four times the thickness of the thicker plate or 50mm, whichever is the smaller. Obtain approval for methods of tack welding steel complying with BS 5950.

The following precautions shall be taken when site welding, (if only approved by Engineer).

1. The surfaces to be welded shall be dry.
2. The surfaces shall be free from spirit, loose rust and mill scale, oil and grease.

All welders shall hold an approved proficiency certificate or approved qualification, appropriate to the class of work on which they are to be engaged. Submit a copy of proficiency certificates on request.

Where welders do not hold approved current proficiency certificates, submit for approval, evidence in accordance with BS 4872 of the proficiency of welders for the class of work to be carried out.

All welds and adjacent surfaces shall be examined visually for the absence of the following defects:

1. Cracks in the weld or adjacent surfaces.
2. Slab inclusions
3. Porosity
4. Lack of fusion at the edge of weld
5. Undercut
6. Concave weld profile
7. Excessively convex weld bead
8. Poor transition between weld and members welded
9. Lack of alignment between components of joint
10. Lack of penetration at the roof of the weld
11. Excessive penetration bead.

Prepare test specimen of weld joints as required. Arrange for the delivery of samples to the testing authority.

Weld specimen shall be tested in accordance with BS 709 or B.S. EN 1043: Parts 1 & 2, BS EN ISO 9016:2011, EN ISO 4136:2011, BS EN ISO 5173:2010, 1320, 1321 & 9018 or equivalent.



3.2.7. Fabrication, Bolting:

Make all bolted connections in accordance with EN 1993 unless otherwise specified.

Do not use drifts in holes which are one-third diameter or more off centre. Use HSFG bolts in accordance with BS 4604, Parts 1, 2 and 3 or equivalent.

Tighten HSFG bolts using the torque-control method.

Use the proprietary bolts and accessories in accordance with the manufacturer's written instructions.

Place washers under black bolts and under heads and nuts of all bolts connecting metal coated steel.

3.2.8. Surface Preparation:

Remove by chipping, scraping and wire brushing loose rust and loose scale, welding slag and spatter 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 2^{1/2} in accordance with SIS 05 59 00.

After blast cleaning, apply a shop primer of 30 µm zincphosphate epoxy primer. Intermediate site applied coat to be 50µm zinc rich epoxy primer. For internal visible steelwork top coat to be 60 µm alkyd (high gloss) or 60µm polyurethane/acrylic paint to architects colour specification

Flux residues and weld spatter should be removed from weld areas before application of coating. Site welds should be treated in such a manner as 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 made joints which 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 a compatible paint or mastic. The nuts and bolts should then be cleaned and the full coating system applied.

For exterior steelwork which is galvanised it is indicated on the drawings. Hot Dip Galvanise to BS 729 85µm minimum. Small areas of damage to galvanised steel, (<40 mm² may be repaired by zinc rich paint.

Early degradation of coatings by blistering, peeling, flaking, cracking, lack of adhesion, etc. must be made good by complete removal, preparation and reapplication of all coats, as instructed. Inadequate dry film thickness or surface defects due to inclement weather may, depending on the type of paint, be remedied by rubbing down and applying further coat(s), as instructed.



Mechanical damage to coatings must be made good by local cutting back of coatings, preparation and reapplication of all coats to leave a neat, continuous and flat finish.

Where damage to coatings of subsequent surface preparation has exposed bare metal, it must be thoroughly cleaned and primed within two hours.

4.0 BLOCKWORK:

4.1 Preparation:

Stack blocks and bricks for facing work on a raised clean platform and protect from damage and staining.

Keep dry during delivery and before use all facing blocks and bricks.

4.2 Laying Blocks & Bricks Generally:

Ensure the stability of blockwork and brickwork during erection.

Do not lay blocks or bricks while the air temperature is below 2°C on a rising thermometer or below 5°C on a falling thermometer.

Walls shall be carried up in a uniform manner, no one portion being raised more than 900 mm above another. Complete each lift in one operation and leave no work racked back at the end of each day.

LEVELLING OF SEPARATE LEAVES: Bring both leaves of cavity walls to the same level at:

- Every course containing vertical twist type ties or other rigid ties.
- Every third tie course for double triangle/butterfly ties.
- Courses in which lintels are to be bedded.

Cut and fit blockwork and brickwork neatly to the line and profile of parts of the structure which the walling abuts or surrounds.

All blockwork to be connected into concrete columns by abbey slots at 225 c/c or as directed on drawings.

LAYING GENERALLY:

- Lay bricks/blocks on a full bed of mortar; do not furrow. Fill all cross joints and collar joints; do not tip and tail.
- Build walls in stretching half lap bond when not specified otherwise.
- Plumb perpends of facework every third or fifth cross joint along a course and even out the joint widths in between.

OVERHAND LAYING will be permitted subject to compliance with this specification and approval of samples and methods of carrying out the work.



4.3 Cavity Walls:

Keep cavities and ties free from mortar and debris.

Set wall ties in mortar joints to a depth not less than 50 mm in each leaf.

Space wall ties in cavity walls in accordance with the drawings.

Provide wall ties at openings or at movement joints at centres not exceeding 225 mm vertically.

Wall ties to comply with IS EN 845:2003 + A1 2008

Wall ties to be of the vertical twist type in stainless steel.

Samples of proposed wall ties to be approved by the Engineer.

4.4 MORTAR:

4.4.1. Materials:

Mortar to comply with IS EN 998-2:2010 Specification for mortar for masonry – Part 2: Masonry Mortar

Aggregates:

Sand for mortar shall be as follows: Type: B.S. 1200.

Lime:

Hydrated lime shall comply with I.S.8. and shall be stored under weatherproof conditions on a raised floor or in suitable silos.

Cement:

Normal Portland Cement (NPC) shall either be certified as complying with I.S. 1 and shall bear the I.S. Mark or shall be certified to a 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.

Cement shall be delivered in unbroken bags as dispatched by the manufacturer or in approved bulk cement delivery vehicles and stored under weatherproof conditions on a raised floor or in suitable silos. Air set cement must not be used.

Water:

Water shall be as described in Concrete Work.

Plasticiser:

Plasticiser shall comply with IS EN 934-2:2009.

Pigment:

Pigment shall comply with IS EN 1014:2010.



MORTAR GROUPS: Where mortar is specified by group number, select any mortar in that group as set out below. Mix proportions are by volume. Use the same mortar throughout any one type of facing work:

Mortar containing cement shall be used within two hours of adding water to the cement.

Mortar shall be mixed sufficiently to incorporate all the constituents of the mix. Where machine mixing is used, the mixer shall be cleaned before starting to mix and before changing the mix or mortar type. Where mortar is mixed by hand it shall be mixed on a hard clean platform.

4.4.2. Preparation:

Cement shall be delivered in unbroken bags as dispatched by the manufacturer or in approved bulk cement delivery vehicles.

Stored sand on a hard self-drained area.

Store hydrated lime under weather-proof conditions on a raised floor or in suitable silos.

Store cement under weatherproof conditions on a raised floor or in suitable silos. Do not use air set cement.

4.4.3. Workmanship:

Mixing:

Mix mortar sufficiently to incorporate all the constituents of the mix. Where machine mixing is used, clean the mixer before starting to mix and before changing the mix or mortar type. Where mortar is mixed by hand; it shall be mixed on a clean platform.

Lay solid blocks and bricks on a full bed of mortar with bed and vertical joints fully filled to a 10 mm average thickness. Vertical joints shall be flushed up as the work proceeds.

All walling shall be carried up in a uniform manner with true and vertical quoins, perpends, etc. and shall be properly bonded. Special angle blocks shall be used at angles and junctions.

Lay blocks and bricks in stretcher bond, i.e. with stretchers only in each course with half lap unless otherwise shown on drawings.

Keep dry each lift of facing blockwork and brickwork, including the top surfaces until the commencement of the next lift or other superimposed work.

4.4.4. Movement Joints:

Expansion joint filler shall be resilient plastic foam strip.

Sealing compound for expansion joints shall be a 2-part, poly-sulphide compound to comply with B.S. 4254.

Joints to be placed in blockwork as shown on drawings



4.4.5. Vertical Joints:

All vertical joints between masonry and structural concrete to be provided with ties as follows:

25 x 2.5 x 150mm (min.) galvanised mild steel channel ties @ max. 450 vertical centres between internal blockwork walls and concrete.

25 x 2.5 x 150mm (min.) stainless steel channel ties @ max. 450 vertical centres between external leaf of blockwork and concrete.

4.4.6. Blockwork:

Blocks used below or near external ground level and in external walls should have a declared mean compressive strength $\geq 13\text{N/mm}^2$. Concrete blocks should be Category 1 masonry units of approved manufacture to I.S. EN 771-3.

Solid blocks for all rising walls and external walls, both the inner and outer leaves, should be Group 1 masonry units and should have a declared mean compressive strength of $\geq 13\text{ N/mm}^2$, tested in accordance with I.S. EN 772-1

Solid blocks for internal walls should also be Group 1 masonry units and should have a declared mean compressive strength of $\geq 13\text{N/mm}^2$ unless the Contractor can provide documentary evidence of a control system that will ensure that mixing of blocks of different strengths cannot occur, in which case blocks with a declared mean compressive strength of $\geq 7.5\text{ N/mm}^2$ would be acceptable.

4.4.6.1 Drying Shrinkage and Control of Movement:

All blockwork must comply with the requirements of Clause 3.6 of I.S. 20 Part 1: 1987 regarding 'Drying Shrinkage' at the time of laying.

For hospital buildings, special precautions must be taken, to ensure that the moisture content of the blocks does not increase from the time the blocks leave the place of manufacture to the time at which they are laid. Specifically, blockwork must be (a) covered in transit, (b) stored under cover at all times, (c) laid in dry conditions in order to minimise the absorption of moisture, and (d) new sections of blockwork must be covered until the building envelope is completed and weathertight.

4.4.6.2 Determination of Drying Shrinkage:

Where required by the Engineer, samples of blocks (specified by the Engineer) shall be sent to an independent laboratory at the contractors expense, and tested in accordance with Appendix C of I.S. 20 Part 1 : 1987, in order to determine the average drying shrinkage of the sample.



4.5 Accuracy:

ACCURACY: Keep courses level and true to line. Accurately plumb all wall faces, angles and features. Unless otherwise specified, build brickwork/blockwork within the following permissible deviations:

Dimension	Permissible Deviation (mm)
Position in plan of any point or specified fair face in relation to the nearest building grid line at the same level	+/-10
Length (unless otherwise defined By adjacent construction):	
Up to 5m	+/-15
5 to 10m	+/-20
10 to 20m	+/-25
Over 20m	+/-30
Height:	
Up to 3m	+/-15
3 to 6m	+/-20
Over 6m	+/-25
Level of bed joints:	
Up to 5m long	+/-10
5 to 10m long	+/-15
Over 10m long	+/-25
Straightness in any 5m length	+/-10
Vertically:	
In any 3m height	+/-10
In o/a height of building Exceeding 6m	+/-20
Thickness:	
Overall thickness of walls or Width of piers (subject to the Following)	+/-15
Difference in thickness of a Wall or width of a pier at any Two points 3m apart	+/-10



4.6 Adverse Weather:

- Do not use frozen materials.
- Do not lay bricks/blocks when the air temperature is at or below 3°C unless mortar has a minimum temperature of 4°C when laid and walling is protected. Do not lay mortar on frozen surfaces.
- Maintain temperature of the work above freezing until mortar has fully hardened.
- Rake out and replace mortar damaged by frost. When instructed, rebuild damaged work.
- Protect newly erected walling against rain and snow by covering when precipitation occurs, and at all times when the work is not proceeding.

4.7 Reinforcing / Fixing Accessories:

WALL TIES FOR ALL BLOCKWORK CAVITY WALLS:

To EN 845-1:2003, type: vertical twist type.

Material/finish: stainless steel.

FIXING TIES IN MASONRY CAVITY WALLS:

- Bed not less than 50 mm into bed joint of each leaf.
- Slope slightly downwards towards outer leaf with drip centred in the cavity and pointing downwards. Do not bend ties to suit coursing.
- Evenly space at 750 mm horizontally, staggered in alternate courses, and at 450 mm centres vertically, unless specified otherwise.
- Provide additional ties within 225 mm of reveals of unbonded opening in every course.

DOVETAIL SLOT FOR BLOCKWORK TO CONCRETE COLUMNS:

Manufacturer and reference: as approved.

Material/finish: stainless steel.

Size(s): as specified on drawings and at 225mm c/c vertically.

FISHTAIL CRAMPS FOR FIXING TO STEEL COLUMNS:

Manufacturer and reference: as approved.

Material/finish: stainless steel.

Size(s): as specified on drawings and at 225mm c/c vertically.

BED JOINT REINFORCEMENT:

Manufacturer and reference: as approved.

Material: Stainless steel.

Width: approximately 40-50 mm less in width than wall or leaf.

Lay on an even bed of mortar in a continuous strip with 225 mm laps at joints and full laps at angles. Keep back 20 mm from face of external work, 12 mm back from face of internal work and finish mortar joint to normal thickness.

MASONRY SUPPORT SYSTEMS:

Masonry support angles are specified on the drawings. The stainless steel is to be Grade 304 or better. Where the soffit of the angle is to be rendered, the angle shall have stainless steel riblath welded to it to provide a key for the render. The Contractor may propose an alternative subject to the Architects and Engineers approval. Any alternative should be demonstrated to be of the same quality, standard and load carrying capacity.

**BI-METALLIC CORROSION:**

All interfaces between mild and stainless steel products are to be separated by the use of isolating membranes, non-conductive waterproof gaskets and nylon or Teflon washers and bushes.

COMPRESSIBLE JOINT FILLER:

Compressible joint filler shall consist of a cork or fibre-based bitumen impregnated filler sheet or strip.

JOINT SEALANT:

Joint sealants shall consist of one part gun graded polysulphide-based mastic to EN ISO 11600:2003 to approved colour and two parts silicone grade-based mastic to EN ISO 11600:2003 to approved colour.

4.8 Lintels:**PRECAST CONCRETE LINTELS:**

To BS 5977-2.

Manufacturer and reference: as approved.

Bed on mortar used for adjacent work with bearing of not less than 150 mm unless specified otherwise. Use slate packing pieces.

PRESTRESSED CONCRETE LINTELS:

Prestressed concrete lintels shall be designed in accordance with EN 845-2:2013

Manufacturer and reference: as approved.

Bed on mortar used for adjacent work with bearing of not less than 150 mm unless specified otherwise. Adequately prop at not more than 1.2m centres during construction of walling above. Retain props in position for not less than 14 days or until mortar has matured, whichever is longer.

PREFABRICATED STEEL LINTELS:

To BS 5977:Part 2.

Manufacturer and reference: as approved.

Material/Finish: galvanized.

Bed on mortar used for adjacent work with bearing of not less than 150 mm unless specified otherwise.

4.9 Collar-Jointed Walls:

Construct collar-jointed walls to the details shown on the drawings.

The vertical joint between the separate leafs shall exceed 8mm and shall not exceed 25mm and shall be filled solidly with mortar as the blockwork proceeds.

The mortar used shall be designation (iii) mortar or better.

Reinforce the bed joints with flat metal ties having 20mm x 3mm cross-sectional area at centres not exceeding 450mm vertically and horizontally or equivalent mesh reinforcement complying with IS 268 at the same vertical centres.

The ties shall be embedded fully in the mortar as required by IS268 and not less than 50mm.



The cover of mortar to the ties or mesh reinforcement shall be not less than 20mm in internal walls and not less than 25mm in external walls.

The type of metal ties or mesh reinforcement and the protective treatment shall be as specified on the drawings

4.10 Testing:

Reference SR 21:2014 + A1:2007 – Guidance on the use of IS EN 13242:2002 – Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction. The constituents of blockwork and maximum contents of acid soluble sulfate (ASS) and total sulfur (TS) to be confirmed as being in accordance with SR 21: 2014

Provide the manufacturers certificate of routine testing for pyrite and compressive strength for concrete blocks. Forward the first certificate to the Engineer on commencement of delivery to site and provide further certificates as necessary to cover subsequent deliveries not included in the scope of the first certificate.

Have the concrete blocks tested for compressive strength and for the presence of pyrite in a laboratory approved by the Engineer. This cost shall be borne by the Contractor.

The Engineer will select the test samples from blocks delivered to site. Each sample shall consist of 10 No. specimens for test plus 2 No. spares for a total of 12 No. Carry out one test per 4,000 concrete blocks delivered to site or as directed by the Architect/Engineer. Carry out one test per truck delivery of all other higher strength concrete blocks delivered to site or as directed by the Architect/Engineer.

Have the testing laboratory copy the test report direct to the Architect and Engineer.

Blockwork not meeting the criteria laid down in this specification and not meeting the requirements of SR:21 2014 to be removed and replaced by the Main Contractor at, no cost to the client.

5.0 CONCRETE SCREEDS/TOPPINGS:

5.1 TYPE(S) OF SCREED/TOPPING:

CONCRETE SCREED to all ground floor areas.

Base: Insulation with polythene sheeting taped at joints.

Construction: Floating.

Minimum thickness at any point: 75 mm.

Reinforcement for crack control: A98

Mix:

Cement: Portland to BS 12 or Portland blastfurnace to BS 146, Class 42.5.

Aggregate: 10mm single sized material conforming to BS 882:1992 Table 3.

Sand: To BS 882, except for grading and fines limits which should be in accordance with Table 5.1 overleaf.

**Table 5.1**

Sieve Size BS410 passing	Proportion by dry Mass Nominal mesh size %
10mm	100
5mm	90-100
2.36mm	65-97
1.18mm	40-90
600µm	24-75
300µm	8-40
150µm	0-10
75µm	0-3

Proportions: (cement:sand:aggregate) 1:3.5:1

Admixture: Water reducing to BS 5075:Part 1, dosage to manufacturer's recommendations. Other requirements: Isolation, expansion and contraction joints as detailed on drawings.

CONCRETE SCREED to all other upper floor areas.

Base: Concrete Precast Units

Construction: Partially Bonded

Minimum thickness at any point: 75 mm.

Reinforcement for crack control: A193

Mix:

Cement: Portland to BS 12 or Portland blastfurnace to BS 146, Class 42.5.

Aggregate: 10mm single sized material conforming to BS 882:1992 Table 3.

Sand: To BS 882, except for grading and fines limits which should be in accordance with Table 5.2 as above.

Proportions: (cement:sand:aggregate) 1:3.5:1

Admixture: Water reducing to BS 5075:Part 1, dosage to manufacturer's recommendations.

Other requirements: Isolation, expansion and contraction joints as detailed on drawings.

5.2 GENERALLY / PREPARATION:

SUITABILITY OF BASES: Before starting work ensure that:

Bases are such as to permit specified levels and flatness/regularity of finished surfaces, bearing in mind the permissible minimum and maximum thicknesses of the screed/topping.

Bases are sound and free from significant cracks and gaps.

Bases are clean and free from plaster, dirt, dust and oil.

SCREEDS LAID ON PRECAST UNITS: The surface should be thoroughly cleaned and dampened 24 hours before the screed is laid, but any accumulation of water in irregularities in the face of the concrete must be removed. A thin brush coat of grout should be applied and well scrubbed in not more than twenty minutes before the screed is laid.



CONDUITS UNDER FLOATING SCREEDS: Haunch up in 1:4 cement:sand on both sides of conduits before laying insulation for floating screeds.

CONDUITS which are to be cast into or under screeds:

Overlay with 500 mm wide strip of steel fabric to BS 4483, reference D49, or welded mesh manufactured in rolls from mild steel wire not less than 1.5 mm diameter to BS 1052, mesh size 50 x 50 mm.

Place the reinforcement at mid depth between the top of the conduit and the screed surface.

PIPE DUCTS/TRUNKING: Before laying screed, ensure that preformed access ducts are securely fixed to the base and accurately levelled in relation to the finished floor surface.

5.3 BATCHING/MIXING/LAYING:

BATCHING: Proportions of mixes made with dense aggregates are specified by weight and, where practicable, should be batched by weight. Volume batching will be permitted on the basis of the previously established weight:volume relationship(s) of the particular materials and using accurate gauge boxes. Allow for bulking of damp sand.

MIXING:

Do not use admixtures containing calcium chloride.

Water content of mixes to be the minimum necessary to achieve full compaction, low enough to prevent excessive water being brought to the surface during compaction.

Mix materials thoroughly to a uniform consistence. Mixes other than no-fines must be mixed in a suitable forced action mechanical mixer. Do not use a free fall type (drum) mixer.

Use while sufficiently plastic for full compaction.

Use ready-mixed retarded screed mortar within the working time and site temperatures recommended by the manufacturer. Do not retemper.

ADVERSE WEATHER:

Do not lay screeds/toppings unless their surface temperature can be maintained above 5°C for not less than 4 days thereafter.

In hot weather reduce the time between operations or use other measures to prevent premature setting or drying out.

JOINTS IN SCREEDS: Unless otherwise specified:

Cast screeds continuously, as far as possible without definite joints, using 'wet screeds' between strips, 4m wide for convenience of application. Form contraction joints either by cutting through with a trowel during laying or by saw cutting after hardening. The joints in the levelling screed should be straight, vertical and at least to mid depth. Saw cutting should not be delayed too long, and should be carried out within 3 weeks of casting. Form day joints with a vertical edge.

LEVELS OF FLOOR SCREEDS/TOPPINGS: Permissible deviation in level of surface of screeds (allowing for thickness of coverings) and toppings from datum: +/- 10 mm.

FLATNESS/REGULARITY OF FLOOR SCREEDS: Sudden irregularities are not permitted. When measured with a slip gauge to BS 8204:Part 1, Figure 3 or equivalent, the variation in gap under a straightedge (with feet) placed anywhere on the surface to be not more than the following:

Screeds to receive topping or beds 15-30 mm thick: 10 mm under a 3m straightedge.



Screed to receive mastic asphalt flooring/underlays:

5 mm under a 3m straightedge.

Screeds to receive a sheet or tile finishes bedded in adhesive:

5 mm under a 3m straightedge.

2 mm under a 1m straightedge.

COMPACTING OF SCREEDS: Compact proprietary screeds using methods recommended by the manufacturer. Compact other screeds as follows:

Compact screed layer(s) thoroughly by mechanical means (e.g. plate vibrator) or, where this is not practicable, by hand using a handrammer or weighted roller.

Lay screeds over 50 mm thick in two layers of approximately equal thickness. Roughen the surface of the compacted lower layer and immediately lay the upper layer.

STAIR SCREEDS/TOPPINGS:

Construction: Bonded to treads, risers and landings.

Form risers with fine finish formwork.

Make good surfaces of toppings with cement: fine aggregate and a wood float, and when hardened rub to remove laitance.

HEATED SCREEDS:

Collaborate with the services subcontractor to ensure that screed bays are properly coordinated with the heating circuits and that all technical requirements are satisfied.

Ensure that the heating elements are properly secured to prevent displacement whilst the screed is laid.

Lay screed carefully ensuring thorough compaction around the heating elements without damaging them.

Ensure that recommendations for curing and controlled heating of screed are followed.

5.4 FINISHING/CURING:

TIMING: Carry out all finishing operations at optimum times in relation to the setting and hardening of the material. Do not wet surfaces to assist surface working. Do not sprinkle cement onto surface.

WOOD FLOATED FINISH: Use a wood float to give an even slightly coarse texture with no ridges or steps.

SMOOTH FLOATED FINISH: Use a hand float, skip float or power float to give an even surface with no ridges or steps.

TROWELLED FINISH: to receive applied floor finishes:

Float to an even surface with no ridges or steps.

Hand or power trowel to give a uniform smooth but not polished surface free from trowel marks and other blemishes, and suitable to receive the specified flooring material.

If, because of inadequate finishing or protection, the surface of the screed is not suitable to receive the specified flooring material, it must be made good by application of a smoothing compound by and to the satisfaction of the flooring subcontractor. Allow for the cost of any such making good.

TROWELLED FINISH for wearing surfaces:

Float to an even surface with no ridge or steps.

As soon as the surface is sufficiently hard, steel trowel by hand or machine.

Retrowel at least twice at intervals until a hard closed finish is obtained and there is little or no effect from further trowelling.



Finished surfaces must be uniform, smooth and free from trowel marks and other blemishes.

DEWATERED TROWELLED FINISH for wearing surfaces:

Immediately after compaction of the concrete, apply the vacuum dewatering process in accordance with the equipment manufacturer's recommendations.

Without delay float the surface using a power float to give an even surface with no ridges or steps.

As soon as the surface is sufficiently hard, steel trowel by hand or machine. Retrowel at least twice at intervals until a hard closed finish is obtained and there is little or no effect from further trowelling.

Finished surfaces must be uniform, smooth and free from trowel marks and other blemishes.

NONSLIP TROWELLED FINISH for wearing surfaces:

Float to an even surface with no ridge or steps.

As soon as the surface is sufficiently hard, steel trowel by hand or machine.

Retrowel at least twice at intervals until a hard closed finish is obtained and there is little or no effect from further trowelling.

Finished surfaces must be uniform, smooth and free from trowel marks and other blemishes.

Apply silicon carbide or aluminium oxide, graded between BS 410 sieves 1.7 mm and 500 micrometres, sprinkling evenly at the rate of 1 kg/sq m. Trowel into the surface while the concrete is still plastic.

POWER GROUND FINISH for wearing surfaces:

Float to an even surface with no ridges or steps.

When concrete is sufficiently hard for sand particles not to be torn from the surface, power grind to remove 1-2 mm from surface to give an even glass paper texture, free from blemishes and trowel marks.

Remove all dust and wash down. Replace waterproof sheeting without delay to complete the specified curing.

CURING: Unless otherwise specified:

Immediately after laying, protect surface from wind, draughts and strong sunlight.

As soon as screed/topping has set, closely cover with polyethylene sheeting and keep in position for not less than 7 days.

Do not heat screeds/ toppings or the building artificially during first 4 to 6 weeks after laying, thereafter raise temperature slowly.

PROTECTION: Adequately protect screeds/toppings from damage and contamination by subsequent building operations.



6.0 PRECAST, PRESTRESSED HOLLOWCORE FLOORS:

6.1 GENERAL:

The precast floor supplier is to be responsible for the design, manufacture, delivery and installation of all units on site.

The supplier shall comply with the Main Contractor's programme for the Works

The supplier should ensure that his activities comply fully with current Health and Safety Legislation

6.2 SLAB DEPTHS:

The slabs in general shall be **150mm** deep.

6.3 DESIGN:

The slabs shall be designed generally in accordance with BS8110 and the Building Regulations

In particular note:

- (a) The serviceability classification (Cl. 4.1.3 – BS8110) shall be Class 2.
- (b) The concrete cover to prestressing tendons shall be 25mm.
- (c) The maximum camber shall be 25mm.
- (d) No composite action with screeds is to be assumed.
- (e) Cores may have to be broken out in some locations to provide for tie requirements
- (f) The minimum bearing for precast units is to be 100mm on concrete and 100mm on masonry

6.4 LOADING:

Slabs shall be capable of carrying the following load cases. (All loads given are characteristic loads, and the self-weight of the units **is not** included in the loadings given).

Loading Case 1 (150mm Unit Floor Loads)

Dead Load TBC kN/sq m.

Imposed Load.....TBC kN/sq m.

6.5 TESTING:

Units may be tested at random on site by loading to 1.25 times the design loads.

6.6 APPROVAL OF SHOP DRAWINGS AND CALCULATIONS

The Engineer shall approve all drawings and calculations relating to the design of the hollowcore units. Such approval shall not relieve the manufacturer of his responsibility to adequately design and manufacture the units. All dimensions for units shall be measured on site and confirmed by the Architects.

6.7 QUALITY:

Any units exhibiting excessive honeycombing, camber, chipping or other defects will be rejected.



Any unit, which is cracked or does not have sufficient bearing, will be rejected.

6.8 CERTIFICATION:

The supplier will be required to certify the design, construction and installation of the units supplied.

7.0 TIMBER:

7.1 Stress Grading:

All structural timber shall be stress graded to the requirements of B.S. 4978 and marked accordingly. The marking system shall identify the stress grade and strength class of the timber member and the registered number of the timber grader and his company.

Moisture Content.

The moisture content of all structural timber, including preservative treated timber, shall not exceed 18% at the time of fixing.

Timber Generally.

Timber shall be free from major defects and such other defects as are likely to impair its intended use.

Nails.

Nails shall comply with I.S. 105 and be of suitable size and type.

Wood Screws.

Wood screws shall comply with I.S. 97.

Black Hexagon Bolts, Screws and Nuts.

Black hexagon bolts, screws and nuts shall comply with B.S. 4190.

Steel Washers.

Steel washers shall comply with B.S. 4320.

Expanding Bolts and Nuts.

Expanding bolts and nuts shall be Hilti HRD frame anchor HRD 10/135, shorter if required.

7.2 Coach Bolts:

Cup head square neck coach bolts shall comply with EN 1494:2000.

7.2.1 Coach Screws.

Square head coach screws shall comply with B.S. 1494 : Part 2.

7.2.2 Mild Steel Framing Anchors.

Mild steel framing anchors shall be Hilti HT frame anchor 10/132 or shorter if required.

7.2.3 Metal Timber Connections.

Metal timber connectors shall comply with EN 912:1999. Finish: galvanised.

7.2.4 Holding-Down Straps.

Wall plate holding-down straps shall be 30mm x 5mm x minimum 750 long galvanised mild steel.

7.3 Prefabricated Roof Trusses:

Timber roof trusses and rafters shall have permanent wind and stability bracing incorporated and the fabricator shall design and fabricate the trusses, including associated diagonal rafter chevron and longitudinal stability bracing and wind bracing to comply with I.S. 193 and EN 1995-1-1:2004 and any information shown on the drawings. Drawings (2 copies), drawing issue sheets and calculations shall be submitted for inspection to the Architect and Engineer at least two week prior to fabrication.



7.3.2 Basic Sawn Sizes.

Timber dimensions in general, which are shown on the Drawings or referred to Elsewhere, shall be basic sawn sizes, unless otherwise indicated.

7.4 Tolerances:

General Tolerances:

The permissible dimensional deviations for timber work generally shall be as follows:

Level: For any nominally horizontal surface when measured from the nearest reference level + 10mm.

Plumbness: For plumb of upper to lower edges of any nominally vertical surface + 2mm in any 1m but not more than 10mm.

In the process of assembly and construction the appropriate softwood shall be selected so that no defect permitted by such grading prejudices the strength of the completed structure at bearings, joints and other assemblies.

Subject to the approval of the architect, pieces rejected may be used for non-structural purposes, provided always that any defects or distortions do not prejudice the intended end use.

7.5 Cross Section -Basic Sizes:

Basic sawn sizes shall be those of EN 1313-1:2010. The permissible dimensional deviation from the basic cross-sectional sizes of sawn softwood timber, measured at 20% moisture content shall not exceed those of B.S. 4471 as follows:

Thicknesses and widths not exceeding 100mm: 1mm, + 3mm.

Thicknesses and widths exceeding 100mm: 2mm, + 6mm.

Minus deviations shall not be permissible in more than 10% of the pieces.

7.6 Planed Sizes, Constructional Timber:

Timber in trusses shall generally be planed. Wherever planed/wrought timber is used, reductions from basic sawn sizes and permissible deviations are given in EN 1313-1:2010 and due allowance is to be taken of the reduced cross-sectional area of pieces in calculations and in applying span tables. Any planing or regularising shall be indicated both in the quantities and on working details, to be submitted for architect's approval and to be in accordance EN 1313-1:2010 which gives reductions from basis size to finished size: $\pm 0.5\text{mm}$ deviation is allowed for planing and for regularised timber resawn or planed to a uniform width, reductions are 3mm off the width only for timber up to and including 150mm. These reductions are not additional to others allowed for resawing and for deviations in sawing. Permissible deviation: $\pm 1\text{mm}$ is allowed for regularised timber.

After planing, softwood already graded to B.S. 4978 (2007) shall be remarked in accordance with paragraph 12 of that Standard.



7.7 Processed Stress Graded Timber:

Where stress graded timber is processed to exceed the permitted reductions it shall be regraded.

7.8 Distortion:

Any piece which is bowed, sprung, twisted or cupped to an excessive extent, having regard to its end use, shall be rejected. The following limits shall not be exceeded: bow, half the thickness in any 3 metres of length; spring, 15mm in any 3 metres length; cup, 1/50th of the width.

Rejected pieces may be used for non-structural purposes, provided that distortion has not been caused by poor weather protection during delivery and on site prior to erection.

7.9 Flatness.

The permissible deviation in flatness of a finished surface at any point under a 1m straight edge placed on the surface in any direction shall be 2mm without any abrupt changes.

7.9.1 Samples Selection. Select samples of the following materials for testing:

Material: Roof Timbers Test: Moisture content in accordance with I.S. 96.

7.10 WORKMANSHIP -STRUCTURAL.

7.10.1 Trussed Rafters, Inspection, Storage and Handling.

Inspect on delivery, store and handle trussed rafters in accordance with I.S. 193.

7.10.2 Storage Generally.

Store timber and timber products protected from the weather, clear of the ground and supported to prevent distortion. If stored in the open or in damp air conditions enclose completely with a suitable covering to prevent deterioration and provide for air circulation and ventilation.

7.10.3 Joints in Structural Timber Work.

Joints in structural timber work generally shall be as shown on the Drawings and shall comply with EN 1995-1-1:2004.

7.10.4 Continuous Lengths.

Install timber members in continuous lengths without splices, where possible, unless otherwise shown or approved.

7.10.5 Contact and Bearing Surfaces.

Ensure full contact of surfaces over the area of joints and over the area of other



bearing surfaces.

7.10.6 Wall Plates.

Install wall plates level with joints halved and lapped where in one thickness and sufficiently lapped where in two thicknesses. Set in a full bed of cement mortar over masonry or concrete bearing walls.

Secure wall plates to walls with holding-down straps placed at not more than 2 metre centres.

7.10.7 Joists Generally.

Space joists at least 50mm clear of flanking masonry or concrete walls. Lay joists with crown or convex side of any camber upwards.

Lay joists at 400mm centres unless otherwise indicated. Where joists bear on a wallplate, skew nail each end to the wall plate with two 100mm long x 4.5mm diameter round plain head nails. Extend joists at least 75mm beyond nearest edge of wall plates but allow a clear space of at least 10mm between ends of joists and masonry or concrete walls.

7.10.8 End Supports/End Bearings

Timber joists are to be supported on heavy duty type joist hangers. Joist hangers shall be fabricated in accordance with B.S 6178: Part 1: 1982 from 2.5mm mild steel and shall be galvanised to BS 729:1971.

Hangers built into 100 thick masonry leaves shall be cavity wall type hangers (i.e with vertical return to top flange). The masonry flange of the joist hanger should be nailed to the blockwork and not the mortar bed to ensure the hanger remains in the correct position while the work progresses. Ensure joist hangers are vertical and that there are no gaps between the back plate and the wall. Avoid positioning the masonry flange directly over a perpendicular joint in the blockwork. Build at least 450mm of bonded masonry above the masonry flange and allow a least twenty four hours for the mortar to set.

Timber joists are to be cut accurately to the length required, making sure that the gap between the end of the joist and the back plate of the hanger is less than 6mm. Packing can be used for gaps up to 10mm. Fit the joists to the hangers and nail through each of the holes provided in the side gussets. Use 32mm long x 9 gauge square-twisted sherardised nails. The joist width should be equal to the width of the hanger and the nominal internal joist hanger depth shall be 10mm less than the joist depth. Where joists bear on trimmer joists, 1.2mm thick galvanised mild steel joist hangers must be used to form the end support and the side legs must be wrapped over the top of the trimmer.

7.10.9 Built-in Members.

Allow a clear space of at least 10mm at sides and ends of joists, beams and other members where built into masonry or concrete supporting structure and provide a minimum bearing of 75mm at supports, unless otherwise indicated.



Where joists are to be built into masonry or concrete supporting walls, treat timber ends with an appropriate colour tinted preservative or provide alternative protection to architects detail.

7.10.10 Beams.

Beams shall be in one piece between supports. Seek approval for joints between continuing lengths and at supports. Provide a minimum bearing of 75mm at supports, unless otherwise indicated.

7.10.11 Rafters.

Fix rafters at 400mm centres, unless otherwise indicated. Skew nail to wall plates with two 100mm, 4.5mm diameter round plain headed nails and nail securely to other roof members.

7.10.12 Purlins.

Purlins shall be in single lengths unless otherwise shown on the Drawings or approved. Joints, where necessary, shall be half lapped over a support.

7.10.13 Solid Bridging.

Fix 35mm x full-depth solid bridging between joists over 125mm deep at spacing not to exceed 2000mm, except when the depth to breadth ratio of joists is greater than 5, then the spacing shall not exceed 6 times the joist depth, unless otherwise indicated. Nail each end of bridging with two 100mm x 4mm diameter round plain head nails.

7.10.14 Cross Bridging.

Fix 75mm x 25mm cross bridging between joists over 125mm deep at spacing not to exceed 2000mm, except when the depth to breadth ratio of joists is greater than 5, then the spacing shall not exceed 6 times the joist depth, unless otherwise indicated. Nail each end of bridging with two 60mm, 2.6mm diameter round plain head nails.

7.10.15 Notches.

Make notches in structural timbers only in approved locations and to approved methods and dimensions.

7.10.16 Holes in Joists.

Drill holes where required in joists, centred at half the depth only and with diameter limited to one-third of the joist depth and a minimum distance of 150mm from edge of hole to end of joist, unless otherwise indicated.

7.10.17 Nails and Screws -Lengths Generally.

Unless otherwise indicated, the length of nails used shall be not less than twice and



screws not less than $1\frac{1}{2}$ times the thickness of the member through which they are driven, but they shall not be longer than the combined thickness of the sections being joined, less 5mm.

7.10.18 Fixing Generally.

Do not insert nails or screws in any end split. Where nailing may cause splitting, pre-bore holes. Drill pilot holes for non-ferrous nails in hardwood. Bore lead holes for all screws.

7.10.19 Bolted Joints.

Drill holes for bolts as close as possible to nominal diameter of bolt but do not exceed 1.6mm larger than bolt diameter. Do not insert bolts in any end splits. Install 50 x 50 x 3 washers under head and nut of all bolts bearing on timber, except under heads of coach bolts. Tighten nuts as far as possible without crushing surface of timber.

7.10.20 Bolted Joints, Inspection.

Where accessible, inspect bolted joints 6 weeks after erection and tighten, if necessary.

7.10.21 Select Pieces.

Select and arrange individual pieces of timber so that knots and other permitted defects will not interfere with proper jointing or fixing or otherwise reduce the strength of assemblies.

7.10.22 Expanding Bolts.

Install expanding bolts and nuts in accordance with the manufacturer's written instructions. Space bolts to avoid cracking due to expansion.

7.10.23 Erection and Fixing

Erect and fix timber trussed rafters, including permanent bracing, in accordance with I.S. 193. Do not cut, remove or modify members or make permanent repairs to damaged trussed rafters without approval.

7.10.24 Battens.

Tiling battens for trussed rafters shall be 44mm deep x 44mm wide, unless otherwise specified on the Drawings, jointed and nailed to comply with I.S. 193.

7.10.25 Trim Work Generally.

Install trims, where possible, in unjointed lengths between angles or in straight runs. Mitre exposed angle joints unless otherwise indicated.



7.10.26 Scribing.

Scribe timber sections to adjoining uneven surfaces unless other treatment is approved.

7.10.27 Nail Heads.

Punch nail heads below surfaces of timber sections to be painted or requiring a smooth surface.

7.10.28 Screw Heads.

Countersink screw heads not less than 2mm below surfaces of timber sections in trim work to allow for stopping.

7.10.29 Pelleting.

Countersink screw heads or bolts not less than 5mm below timber surfaces which are to be clear finished. Cut pellets from similar grained matching timber and glue in place with grain aligned. Finish flush with surfaces.

7.10.30 Nailed Joints.

Nail butt joints in framing work as follows: Studs to Plates: Skew or end nail with not less than two nails at each joint.

Lintels and Sills to Studs: End nail with not less than two nails at each joints.

Nogging to Studs: Skew or end nail with two nails at each joint.

7.10.31 Head Plates.

Fix sole or head plates to blockwork or timber trusses at 600mm centres with frame anchors or black bolts, respectively.

7.11 LAMINATED TIMBER MEMBERS

7.11.1 Scope of Work.

The detailed design, fabrication, protection and erection of structural laminated timber is as shown on the drawings and specified in this section.

7.11.2 Design and Co-ordination.

Complete the design and detailing of the work and provide complete information (including fabrication/erection drawings, drawing issue sheets, all design calculations, specifications, etc.) at least 3 weeks prior to commencement of fabrication, based on the information provided and any site measurements required, liaising with the Engineer and others, as necessary, to help ensure co-ordination of the work with related building elements.

Request additional information and provide information as necessary in time to meet the programme. Submit two copies each to the Engineer and Architect for



checking. Make any necessary amendments in accordance with any comments of the Engineer and/or Architect and re-submit unless the Engineer confirms that this is not necessary. Should any amendment by the Engineer be considered to be a variation, notify the Engineer without delay and do not proceed until subsequently instructed.

7.11.3 Basis of Design

The structural laminated timber shown on the drawings and described in this specification shall be designed to comply with all current Irish, British and European standards:

- EN 1995 The structural use of timber
 - BS EN 302 Synthetic resin adhesives (phenolic and aminoplastic) for wood.
 - BS 8417 (2011) Guide to the choice and application of wood preservatives.
 - EN 386 (2001) Manufacture of glue-laminated timber structural members.
 - BS 4978 (2007) Timber grades for structural use.
- EN 1995-1-1:2004 Structural use of timber. Code of practice for permissible stress design, materials and workmanship.
- EN 1995-1-1:2004 Code of practice for the structural use of timber. Preservative treatments for constructional timber.
 - N 385:2001 Manufacture of finger joints in structural softwoods.

Laminated timber supplied with EN 386:2001 will be manufactured from a species of timber whose mechanical properties are given in BS 5268. Part 2. This requires that, where softwoods are used, they are stress graded in accordance with BS 4978:2007. Hardwood laminations must be stress graded in accordance with BS 5756.

The Subcontractor must complete the design and detailing of the work to the above stated standards to satisfy loading requirements specified or otherwise calculable from the information given.

7.11.4 Proposals for Erection.

Submit details of the following for checking at least three weeks before the commencement of the laminated timber erection:

- i. Method of Erection.
- ii. Temporary supports, guys and bracing
- iii. Type of craneage
- iv. Erection programme

7.11.5 Approved Firm.

The fabrication and erection of the structural laminated timber shall be carried out by an approved firm or firms.

7.11.6 Holding Down Systems.

Provide holding down systems and associated setting-out drawings on site in good time for inclusion in the works by the Main Contractor. Installation of holding down



systems in accordance with the setting-out drawings is the responsibility of the Main Contractor.