



**SPECIFICATION FOR
CONCRETE WORKS**

FOR

**CONCRETE 'ROADWAY'
IN TUNNEL AT
HSE LABORATORIES
HARPUR HILL**

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GENERAL

1.1 Scope

This specification covers the requirements for structural concrete works in the tunnel at Health & Safety Executive's site at Harpur Hill, Buxton. Some clauses refer to work not required in the contract, but are included for any requirements in case of variations.

1.2 Standards and Codes

All materials and workmanship shall be in accordance with the current issue, including amendments of the BS EN 1992, Eurocode 2: Design of concrete structures, particularly BS EN 1992-1-1:2004, and the requirements of this specification.

1.3 Approval

The expressions "Approved" or "Approval" shall mean the review by the Engineer in writing.

1.4 Responsibility

No approval, or any acceptance by the Engineer, shall in any way relieve the Contractor of his responsibility under the Contract for the quality of materials, the standard of workmanship, and for the strength, durability and appearance of the finished works.

1.5 Site Safety

The contractor must ensure that the works are carried out in a manner that ensures the safety of all site personnel and members of the public. Method statements outlining how this is to be achieved are to be submitted to the Engineer at least 14 days prior to the work commencing.

1.6 Defective Works

Where in the opinion of the Engineer or Client's Representative any part of the finished works or the materials or workmanship in any part of the works do not comply with all the relevant requirements of this specification, that part of the work shall be classed as defective work and shall be cut out and removed from the works and replaced or otherwise dealt with as directed by and to the satisfaction of the Engineer.

All costs of or charges arising from the removal and replacement of defective works will be at the Contractor's expense.

1.7 Tolerances

The following tolerances have been used when considering the various building components. Unless otherwise indicated on the drawings the location and dimensions and levels of finished works shall be within the tolerances given below.

1.7.1 Setting-out Reference Grid

At every structural level the horizontal reference grid set out by the Contractor shall be within $\pm 0.05\%$ of the dimensions given by or computed from the drawings. The reference grid at each level shall be vertically above the corresponding grid on the level immediately below within $\pm 0.05\%$ of the vertical distance between the grids being considered.

1.7.2 Position of Structural Elements

The centre line position of all structural elements shall not be more than $\pm 3\text{mm}$ from the correct positions or levels shown on the drawings or otherwise specified.

All structural elements shall not be more than 6mm out of plumb in any storey height and must be corrected on subsequent storeys. If a storey height is not defined then the element shall not be more than 6mm out of plumb in any 3 metres and not more than 15mm out of plumb in the total height.

1.7.3 Sizes of Structural Members

The sizes of structural members shall be within the following maximum tolerances, which are not cumulative.

- i) Concrete below ground:

All dimensions less than 3.5 m	± 10mm
All dimensions of 3.5 m and over	± 15mm
Top surface level	± 5mm
Centres of holding down bolts	± 10mm

- ii) For all other concrete unless otherwise specified:

All dimensions less than 3.5 m	± 3mm
All dimensions of 3.5 m and over	± 6mm
Distance between column or wall faces	± 4mm
Openings	± 4mm
Twist and straightness or bow of a face:	
Dimensions less than 3.5 m	5mm
Dimensions of 3.5 m and up to 10 m	10mm
Dimensions of 10 m and up to 15 m	15mm
Cast in fixings	± 3mm
Reinforcement cover	± 5mm

- iii) Ground slab surface levels:
 - Local variations shall not exceed ± 3mm in any 3 m length
 - There shall be no difference in level across any joint
 - At the ends of the roadway slab and at walls, the level shall vary by not more than ± 3mm relative to the datum.
 - An overall level tolerance of ± 6mm relative to the datum

1.8 Testing Authority

The testing Authority shall be an organisation nominated by the Contractor and fully equipped to carry out all tests and checks required by this specification and approved by the Engineers.

2 MATERIALS

2.1 General

All materials used shall comply with the appropriate European and British Standards.

2.2 Cement & PFA

Cement shall be "Ordinary Portland" cement complying with BSEN 197-1 or Portland blast furnace cement complying with BS146 or sulphate-resisting Portland cement complying with BS4027.

Pulverised Fuel Ash for use as a constituent of structural concrete shall be in accordance BS3892.

All cements shall be delivered to site in sealed bags or sealed tins or bulk cement trucks of approved design.

2.3 Aggregates

Aggregates generally shall be natural sand gravel or crushed gravel or rock complying with the recommendations of BS882.

The fine aggregate is to conform to Table 5 Zone C or Zone M, as defined in BS882.

2.4 Water

The water to be used in the works shall be clean and free from all harmful matter either in suspension or solution. The water shall comply with the requirements of BS3148. In general, water fit for drinking is fit for making concrete.

2.5 Testing of Material

Before commencement of the Works the Contractor shall submit sufficient samples of the materials he proposes to use to an approved Testing Authority for testing and analysis of the cement to BSEN 197-1 or BS146 or BS4027 and aggregates to BS882. A sufficient sample of the water shall also be submitted to the Testing Authority for chemical analysis.

The source of supply of the aggregates shall not be changed after approval of the Engineer without prior permission of the Engineer in writing.

Concrete shall be sampled, and cubes made, cured and tested in accordance with BS1881.

2.6 Storage of Material

All cements shall be stored in a suitable weatherproof and reasonably airtight structure of adequate size, having a raised dry floor.

Aggregates shall be stored on hard paved self-draining areas with adequate dividing walls separating the different grades.

Both cements and aggregates shall be used in the order in which they arrive on site.

Reinforcement shall be stored on racks clear of the ground.

2.7 Admixtures

The Engineer may permit the use of admixtures, provided complete details of the mix proportions and workability have been submitted to him for approval. Such permission shall only be given as long as the Engineer is satisfied that the concrete complies with the specification.

2.8 Salts

The salt content (anhydrous) of the aggregates shall not exceed 0.15% of the aggregates weight.

The total chloride content of the concrete mix shall not exceed 0.32% of the cement by weight for reinforced concrete. Where cement complying with BS4027, or pressurised concrete is used the total chloride content shall comply with the requirements of BS8110 table 6.4.

2.9 Alkali - Aggregate Reactivity

Aggregates containing materials that are detrimentally reactive with alkalis in the cement shall not be used in a quantity sufficient to cause damage to the mortar or concrete.

Tests for potential alkali reactivity shall be carried out in accordance with ASTM C289. Should any test show that a potentially detrimental degree of reactivity exists then additional tests in accordance with ASTM X227 and C586 shall be carried out.

Where tests have not been carried out or where it cannot be proved that the aggregates do not contain detrimental material then cement with an alkali content less than 0.62% (calculated as equivalent sodium oxide) shall be used.

Cements having an alkali content greater than 0.6% may be used provided the total alkali content of the concrete does not exceed 3 kg/m³ of sodium Oxide equivalent.

3 DESIGN AND CONTROL OF CONCRETE MIXES

3.1 Requirements for Design Mixes

The following grade of concrete is required in the works:

Mix Designation	Roadway
Grade	C30/37
Specified 28 Day Cube Strength (N/mm ²)	37
Cement Type	PC to BSEN 197-1
Minimum Cement Content (kg/m ³)	300
Maximum free water/cement ratio	0.60
Maximum Coarse Aggregate Size (mm)	20
Special Requirements	Assuming that there is no risk of frost damage then air entraining is not required

* Special requirements: refer to Clause 3.1.1.

3.1.1 Summary of Table of Requirements for Design Mixes

Each concrete grade is to be used where indicated on the drawings; the following is a brief summary:

- The **Roadway** design mix is for an internal ground bearing slab, with no finishes. This concrete mix must be designed to have optimum drying shrinkage characteristics, as follows:
 - Carboniferous limestone coarse aggregate or an approved alternative must be used to optimise shrinkage characteristics.
 - A water-reducing admixture to help plasticise the mix and minimise drying shrinkage must be used. This admixture must be approved by the Engineer and must be added to the concrete under controlled conditions at the time of mixing.
 - Cement substitutes must be used either PC to BSEN 197-1 with min 25%, max 40% PFA or PC to BSEN 197-1 with maximum 40% cement replacement (GGBFS)
 - The Contractor is to prepare a submission to the Engineer to illustrate that his proposed mix minimises water content and drying shrinkage whilst retaining the required strength and durability requirement. Alternative mixes to the above specification will be considered provided that it can be shown that shrinkage is minimised, and that strength and durability are acceptable.

All mixes are subject to the approval of the Engineer whose word is final.

3.2 Determination of Mix Proportions for Site Mixed Concrete

Mix proportions shall be determined by the Contractor using an approved method for each of the grades of concrete specified above as required. All relevant information regarding the mix proportions by weight for each grade of concrete shall be submitted to the Engineer prior to preliminary test cubes being made.

The mix proportions shall be such that the designed mean strength at 28 days shall exceed the specified strength at 28 days by twice the design standard deviation. Initially the design standard deviation shall be $7\frac{1}{2}N/mm^2$.

The concrete shall have sufficient workability to be placed and compacted by the methods to be used on site.

3.3 Acceptance of Mix Proportions for Site Mixed Concrete

Before any grade of concrete is placed in the works six cubes from each of three trial mixes of the grade shall be made, three for testing at 7 days and three for testing at 28 days and the results submitted to the Engineer as soon as available.

The mix proportions shall be accepted for use in the works only if the 28 days cube strength fulfils the following conditions:

- the average strength of each set of cubes exceeds the design mean strength,
- the difference between the lowest and highest strengths of any one set does not exceed 15% of the average of that set,
- the difference between the lowest and highest strengths of all three sets does not exceed 20% of the average of all three sets and,
- each individual test result is greater than 95% of the specified strength.

3.4 Site Control

The contractor shall carry out the following:

- The quantities of cement and aggregates for each batch shall be weighed separately in approved weight batching equipment.
- The weight batching equipment shall be checked weekly by an approved method.
- The water gauging equipment shall be checked weekly.
- The moisture content of the aggregates shall be determined daily in accordance with BS812 and the amount of added water adjusted accordingly to maintain a constant water cement ratio.
- One bag of cement in every 100 shall be check weighed.

- For each consignment of cement copies of the manufacturers certificates of tests in accordance with BSEN 197-1 or BS4027 shall be obtained and examined for variations and copies submitted to the Engineer.
- The grading of the aggregates shall be checked weekly, or at such times as may be appropriate.

The workability of the concrete shall be checked at least twice during any pour or every 20m³ of concrete by means of either the slump test or compaction factor test in accordance with BS1881.

All the above checks and tests shall be carried out by the Testing Authority. If as a result of the checks and testing any variations or discrepancies are discovered, these will be corrected immediately to the satisfaction of the Engineer.

3.5 Ready Mixed Concrete

The Engineer may permit the use of ready mixed concrete provided complete details of the mix proportions and workability have been submitted to him for approval. Such permission shall only be given for as long as the Engineer is satisfied that the concrete complies with this specification and the recommendations of BS8500.

The plant must be certified as a BRMCA approved depot (A to E).

The Engineer may require a slump test and test cubes from each truck load prior to the concrete being placed.

Each load shall be accompanied by a delivery note stamped with the time of mixing and stating the consignee and quantities of each material including water and admixtures.

No extra water or other materials shall be added after the concrete has left the depot, unless agreed with the Engineer.

3.6 Consistency of Concrete

The amount of slump is to be not less than 25mm and not more than 75mm measured from a standard slump cone. In addition the slump should not vary by more than ± 25 mm from the specified slump for that concrete. Concrete used in workability tests shall not be reused for making cubes.

3.7 Sampling of Works Concrete

The concrete is to be tested for compressive strength at the rate of one sample per 10cu m or 10 batches whichever represents the lesser volume, but not less than one for each day of use. The samples shall be taken at the mixer from typical batches at discharge or as directed by and in the presence of the Engineer without prior notice. From each sample three test cubes shall be made one for testing at 7 days and two at 28 days.

The minimum rate of sampling for the testing of the concrete is to comply with the recommendations of BS8500.

The Contractor shall maintain on site a complete record of the date and time and grade and location in the works of the mix from which the sample was taken and shall submit this information with the test results to the Engineer as soon as they are available.

3.8 Rejection of Works concrete

If the strength of any cube tested at 28 days is less than the specified 28 day strength or if the strength of any cube tested at 7 days multiplied by the average ratio of 28 day to 7 day strengths for that grade of concrete as determined from the relevant trial mix results is less than the specified 28 day strength then no further work shall be carried out on that part of the work containing the mix from which the cubes were taken until a full investigation into the cause has been carried out by the Contractor to the satisfaction of the Engineer.

If as a result of the investigation the Engineer decides that the concrete does not meet the requirements of this specification, then the concrete will be classed as defective work.

In addition, the 28 day works cubes results of each grade shall be examined in consecutive (but not overlapping) sets of four for which the average and the range of each set shall be calculated. If the results of any ten consecutive (but not overlapping) sets do not satisfy all the following conditions the concrete shall be classed as defective work:

- No more than 2 individual results of the cubes tests shall fall below the specified 28 day works cube strength.
- No individual result shall be less than 95% of the specified 28 day strength.
- No value of the range in any set shall exceed four times the design standard deviation.
- No value of the average for any set shall be less than the specified strength plus the design standard deviation.
- The standard deviation of all 40 cube sets shall be less than the design standard deviation.

4 CONCRETE MIXING, PLACING AND CURING

4.1 Mixing

The concrete shall be mixed in an approved mechanical batch type mixer. Mixing shall continue until the whole mix is uniform in colour and consistency and the mixing time shall not be less than two minutes. The volume of mixed material shall not exceed the rated capacity of the mixer.

Each batch of concrete shall be completely discharged before the mixer drum is recharged.

4.2 Transporting

The concrete shall be transported as quickly as possible from the mixer to its final position in approved containers without segregation or loss of any of the ingredients.

All containers shall be kept clean and shall be thoroughly washed out whenever mixing ceases.

4.3 Placing

Concrete shall be placed in its final position while still sufficiently plastic for full compaction and well tamped around reinforcement into all parts of the formwork so as to leave no voids and shall be carried out continuously to predetermined construction joints.

The Contractor shall keep on site a complete record of the time and date when concrete is placed in the works. This record shall be available at all times for inspection by the Engineer.

4.4 Compacting

The concrete shall be thoroughly compacted during placing to the maximum possible density using approved mechanical vibrators in a manner which does not cause segregation, surface laitance or grout loss.

4.5 Curing

All surfaces of freshly placed concrete shall be kept moist by an approved method, preferably polythene / Visqueen dampened underneath and taped down at edges, for a minimum period of 7 days.

Soffit and side formwork left in position will be regarded as effective in keeping those surfaces moist.

4.6 Concreting in Cold Weather etc

No concrete is to be subjected to any load within five days of being poured and it is to be protected from sun and frost and kept wet whilst setting. All concreting is to be suspended when the air temperature is less than 34°F (1°C) on a rising thermometer and 37°F (3°C) on a falling thermometer. The Contractor shall ensure that the concrete temperature will not fall below 40°F (5°C) for the specified curing period. Concrete injured by frost, or if otherwise defective is to be cut out and the work reconstructed.

Before the onset of cold weather the Contractor shall submit to the Engineer his proposals for concreting under such conditions for approval.

4.7 Concrete in Watertight Construction

All work so indicated on the drawings shall be watertight and the Contractor shall obtain the approval of the Engineer for any waterproofing measures he proposes to use to maintain the watertight nature of the finished works.

5 REINFORCEMENT

5.1 General

Mild steel and high tensile steel bar reinforcement shall comply with BS4449. High yield steel shall be of the deformed type 2 throughout.

All mesh reinforcement is to be high tensile steel wire fabric in accordance with BS4483 and shall be delivered in flat sheets. Special attention should be given to the longitudinal laps of the steel mesh (not less than sixty diameters). Cover is to be 50mm from the top, longitudinal bars to the surface and 50mm to the sides and the side edges. Proprietary spaces shall be used to ensure the steel mesh fabric is placed with the required cover and so that the mesh does not deform under the traffic of work-persons carrying out the work.

Where required by the Engineer the Contractor shall submit sufficient samples of the reinforcement to an approved Testing Authority for testing in accordance with the relevant European and British Standard. The tests shall include bend and re-bend testing.

5.2 Cutting and Bending

All reinforcing bars and mesh shall be accurately cut and shaped to the details shown on the bending schedules and on the drawings in a manner that will not injure the material.

Reinforcing bars shall not be heated unless approved by the Engineer.

5.3 Cleaning

Reinforcing bars shall be free of all rust, loose mill scale, oil, grease and any other harmful matter.

5.4 Placing

All reinforcement shall be accurately placed, securely fixed and adequately maintained in the positions shown on the drawings by use of approved methods.

Dense cement blocks or other approved means shall be used to ensure the specified cover.

Boards or gangways for concrete transporters or foot traffic shall be kept clear of the reinforcement.

5.5 Rates

The rates for steel bars and fabric reinforcement shall be deemed to include bends, hooks, tying wire, distance blocks, ordinary spacers and chairs.

5.6 Welding

Welding of reinforcement shall not be carried out unless approved by the Engineer. Welding when permitted is to be carried out in accordance with BS5135 or such other requirements as may be requested by the Engineer.

6 FORMWORK

6.1 General

Before construction commences the Contractor shall notify the Engineer of the general method and systems of formwork he proposes to use.

The formwork shall be constructed and supported in such a way that it will withstand all the forces imposed by the weight of the finished works, placing, vibrating of wet concrete and any live or other incidental loads without displacement or visible deflection. All joints in the formwork, joints between the formwork and previous work shall be constructed in such a way as to prevent any loss of liquid from the concrete.

Methods of fixing and locating formwork that result in holes through the concrete section when the formwork is removed shall not be used.

No metal part of any device for maintaining the formwork in its correct location shall remain permanently within the specified concrete cover.

Side screed rails (shuttering) are to be minimum 1000mm high to enable the ducting to be placed alongside the concrete once the screed rails (shuttering) is removed.

6.2 Propping

All vertical propping to formwork shall be carried down sufficiently far to provide the necessary support without damage or overstress or displacement to any part of the construction.

All formwork to soffit shall be designed in such a way that the majority of the formwork can be removed without disturbing those props, which carry the weight of the new construction. These structural props shall be sufficiently strong to carry the weight of the new constructions and any other loads (including wind) which may be placed on it prior to their removal.

Re-propping shall not be permitted.

Structural props shall be so positioned that they divide the clear span of any member into equal lengths not exceeding 3 metres.

6.3 Beam and Slab Formwork

All formwork to the soffits of beams and slabs shall be constructed with the following upward cambers:

- a) Spanning between supports: 0.1% of span at centre
- b) Cantilevers: 0.4% of span at free end

6.4 Final Preparations

The internal faces of the formwork may be coated with an approved preparation to prevent adhesion of the concrete to forms, provided that the use of this preparation will not stain the surface of the finished concrete. None of this preparation shall be allowed to touch the reinforcement.

Immediately before the concrete is placed in any section of the formwork the interior of that section shall be completely cleared of all extraneous materials.

The Engineer shall be given adequate notice of the preparation of each section of the formwork to structural members which shall be made available for inspection and acceptance by the Engineer immediately before the concrete is placed in that section.

6.5 Striking of Formwork

The structure shall not be distorted, damaged or overloaded in any way by the removal of the formwork or propping from concrete members. Generally the concrete strength must have reached at least twice the stress which the concrete may be subjected.

The responsibility for the safe removal of any part of the formwork or propping shall rest with the Contractor.

The minimum time from completion of placing concrete to the removal of formwork from structural members shall be determined from the following table:

Location	6.5.1 Minimum Striking Times	
	PC & SRPC	High Early Strength ¹
Beam and Wall Sides and Columns	1	1
Slab Soffits (Structural props left in)	6	2½
Beam Soffits(Structural props left in)	15	4
Slab Structural props	15	7½
Beam Structural props	21	11

The times are given in days where each day is to be of 24 hours duration during which the surface concrete temperature is above 5°C (40°F). Any time for which the concrete temperature has been below 5°C (40°F) shall not be counted. The minimum striking times assume that the concrete is carrying only its own weight.

6.6 Construction Joints

The position of construction joints if not indicated on the drawings shall be agreed with the Engineer before work is commenced. All joints shall be formed in neat horizontal lines using rigid formwork.

Construction joints shall be positioned to limit the maximum pour size to 200m² and maximum length of ~15m to match the steel tunnel sections.

Prior to placing concrete against a construction joint all laitance and honeycombed concrete shall be removed to within 25mm of the edges by hacking or air and water jetting and the surface left clean.

6.7 Wrought Formwork

Wrought formwork is to be such as to leave the concrete with a smooth and even face free from all voids, fins and board marks, and with true and clean arises.

7 FINISHES TO CONCRETE FACES

7.1 General

After removal of formwork no treatment of any kind other than that required for curing the concrete shall be applied to the concrete faces until they have been inspected by the Engineer and client's representative.

After inspection all superfluous fins and similar projections shall be carefully removed. No render or other applied finish shall be used to obtain a fair face to the concrete.

Unless otherwise specified all concrete faces to be exposed in the finished works shall be left as struck with a fair face and true line and level within the specified tolerance for the works. They shall be adequately protected against damage and surface staining during the execution of subsequent works. The minimum standard of finish will be type B to BS8110.

¹ Early strength is indicated as N for Normal early strength and R for high early strength
Where R is specified, refer to the engineer for further advise

7.2 Sample of Finishes

The Contractor shall produce samples of any specified finish to exposed concrete for approval. The samples shall be cast and treated by the method to be used in the works. The samples shall be placed in a suitable position as directed by the Client's representative or Engineer and shall be protected and remain in position until the works are completed, when they shall be demolished and removed from the works.

7.3 Concrete Finishes - Formed

The surface finishes additional to those required in the general specification shall be one of the following types.

7.3.1 Class F1 - Exposed fair faced

The formwork shall be lined with or constructed from a material approved by the Client's representative and Engineer to provide a smooth finish of uniform texture and appearance. This material shall leave no stain on the concrete and shall be so joined and fixed to its backing that it imparts no blemishes. It shall be of the same type and obtained from only one source. The Contractor shall make good any imperfections in the resulting finish as required by the Client's representative and Engineer. A sample panel containing one construction joint and approximately 1.5m x 1.0m x 0.1m will be required.

The Contractor shall ensure that the aggregates, concrete mix, surface release agent, absorption of formwork and any other factors which may affect the surface colour or texture do not change during the execution of the works.

7.4 Concrete Finishes - Unformed

If no unformed finish is indicated, unformed surfaces shall have finish U2.

7.4.1 Class U1 - fine tamped

The concrete shall be uniformly levelled and tamped to a "fine tamped texture" to the Client's representative's approval and free from laitance.

7.4.2 Class U2 - wood float

When the concrete is sufficiently hard the U1 finish shall be wood floated by hand sufficient only to produce a uniform surface to the Client's representatives approval.

7.4.3 Class U3 - steel float

When the concrete is sufficiently hard to prevent laitance from being worked to the surface, the surface shall be steel floated by hand or machine to produce a dense smooth uniform surface free from trowel marks to the Client's representative's approval.

7.4.4 Class U4 - wire brush

The surface finish is to be wire brushed to the approval of the Client's representative. The wire brush texture shall be as described in the HMSO Specification for Roads and Bridge Works.

Where required the slab margins shall be subsequently steel floated to finish Class U3.

7.5 Quality of Concrete Finishes

Any finished work which the Client's representative or Engineer judge inferior in any respect to the standard of the relevant approval sample or which is subjected to subsequent damage or surface staining shall be rejected and treated as defective work.

8 GROUND SLABS

8.1 General

The general requirements of the concrete specification shall apply to concrete ground slabs.

For ground bearing slabs, construction bays and joint layout shall be detailed by the Engineer in accordance with the "Long Strip" method of construction. Alternative proposals by the Contractor to suit overall planning shall be to the Engineers approval.

8.2 Grades

The concrete for ground slabs shall be as specified. The concrete shall be air entrained $4\frac{1}{2}\% \pm 1\frac{1}{2}\%$ for external ground slabs. The concrete shall have maximum slump of 50mm.

8.3 Tolerances

Ground slabs shall be laid to the tolerances specified in BS8204 and as follows:

- Local variations shall not exceed ± 3 mm in any 3m length.
- There shall be no difference in level across any joint.
- At walls, partitions and doorways etc. the level shall vary by not more than ± 3 mm relative to the datum.
- An overall level tolerance of ± 6 mm maximum relative to the datum.
- With applied finishes less than 40mm thick the level tolerance is to be +3 or -6mm relative to the datum.

8.4 Formwork

Formwork shall be timber or steel road forms both to be true to line with level tops and well-defined edges. The formwork shall be supported in a manner that does not puncture the slip membrane.

8.5 Slip Membrane

All ground slabs shall be laid on a minimum 500-micron (2200 gauge) Visqueen sheet damp-proof membrane, or as specified by the Client's representative, having minimum 150mm folded and taped laps.

8.6 Curing

The surfaces of freshly placed concrete shall be protected from the effects of sun, wind, rain and frost and anything likely to damage the ground slabs. The Contractor is to propose to the Engineer, for the Engineer's review and comment, the Contractor's method of curing in advance of any concrete pours and in sufficient time to plan and procure appropriate measures.

All surfaces of freshly placed concrete are to be kept moist for a minimum period of 7 days. Wetted hessian or sand or water spraying shall not be used to maintain a moist surface.

The concrete roadway can be cured by treating with a resinous curing compound spray applied at a rate of $3\frac{1}{2}$ to $4\frac{1}{2}$ m² per litre and shielded from sunshine or rain by opaque waterproof sheets at the tunnel ends.

8.7 Joints

The joints shall be formed true to line and level. The dowel bars or mesh shall be rigidly fixed in position to stay parallel to the slab surface and square to the joint.

8.8 Sequence of the Works

The Contractor is to propose to the Engineer, for the Engineer's review and comment, the Contractor's sequence of construction for all concrete pours