SECTION R11

Concrete curbs and concrete channels cast-in-place

R11 01 Scope

This Specification shall apply to the following items:

l. Concrete curb (cast-in-place).

2. Monolithic curb and channel (cast-in-place).

R11 02 Design

Curbs and channels shall be of the designs shown on the Drawings.

The locations at which curbs and channels are to be installed and the type or design to be used at each location shall be as indicated on the Drawings or the Special Specification of Particular Application, or as ordered by the Engineer's Representative.

R11 03 Provisions of part II, section B8 to apply

The curbs and channels shall be constructed in accordance with the specification for "Structural Concrete" as given in Part II Section B8, to such extent as the provisions of that specification are applicable and are not in conflict with the provisions which follow.

R11 04 Class of concrete

Unless otherwise specified, the concrete to be used in curbs and channels shall be Class D/20.

R11 05 Lines and grades

Curbs and channels shall be constructed to lines and grades shown on the Drawings or as approved by the Engineer. Curved sections shall be constructed at street intersections, and either curved sections or depressed sections shall be constructed at driveway connections and elsewhere, when shown on the Drawings or ordered by the Engineer's Representative.

R11 06 Transverse expansion joints

Transverse expansion joints shall be provided opposite all expansion joints in abutting concrete pavement and at each tangent point in the curb or channel alignment. Additional transverse expansion joints shall be provided at other locations as required confining the expansion joint spacing to a maximum of 14m.

Expansion joints shall be filled with preformed filler material of the kind specified for use in transverse expansion joints in Portland Cement Concrete Pavement (see Clause R10 02 (7))

The thickness of the expansion joint filler shall be not less than 1cm and. in joints opposite expansion joints in abutting pavement, the thickness shall be not less than the thickness of the filler in the pavement joints.

Each expansion joint shall be accurately set at right angles to the curb or channel and shall provide the complete separation of the concrete which is intended.

R11 07 Dowels at expansion joints in channels

At expansion joints in channels and in the channel portion of curbs and channels built monolithically, dowel bars shall be provided as a load transfer medium. The dowel bars shall be as shown on the Drawings, and they shall be painted and provided with "slip sleeves". The means used in the installing of the dowels shall be such as will ensure accurate placing and as will positively avoid displacement of the bars during the placing and finishing of the concrete.

The size and spacing of the dowel bars shall be as indicated on the Drawings. Each dowel shall be set accurately parallel to the top surface of the channel and accurately at right angles to the expansion joint.

R11 08 Contraction joints

Transverse contraction joints shall be provided opposite all contraction joints in abutting concrete pavement and at other locations as required to confine the contraction joint spacing to a maximum of 4m.

The contraction joints shall be of the weakened-plane type and shall be provided by forming grooves in the face and surface of structures at right angles to the curb alignment and curb surface. The grooves shall be rectangular in cross-section, 5cm deep by 5mm wide. The grooves shall be formed in the top of all curbs, in the batter side of independent type curbs, in the exposed roadway face of curbs and in the channel surface of monolithic type curbs and channels and in the surface of channels. The edges of joints shall be tooled and the joints shall be left clean, neat and of the specified width and depth.

R11 09 Steel tie bars

When shown on the Drawings, concrete channels shall be tied to the abutting pavement by means of steel tie bars. The size, length and spacing of the bars shall be as indicated on the Drawings.

R11 10 Curing of concrete

During the 72-hour period following the placing of concrete, the curbs and channels shall be protected against premature drying by covering with suitable cotton or Hessian mats and by frequent sprinkling with water, with liquid membrane-forming compounds or with waterproof paper as set forth in Clause R10 16, or by other curing methods approved by the Engineer's Representative.

R11 11 Backfilling

After the forms have been removed and the concrete has been cured as specified, the excavations shall be backfilled with suitable materials tamped solidly into place.

Where the verge, shoulder or footpath at the back of the curb has been disturbed by curb construction such areas shall then be graded and shaped to the specified cross-section or to lines and slopes designated by the Engineer's Representative.

Excess excavation materials shall be disposed of in a manner satisfactory to the

Engineer's Representative

R11 12 Measurements

The unit of measurement for concrete curbs shall be the linear meter. The number of linear meters shall be the accepted lengths of concrete curbs as measured in place. Measurement will not include any areas in excess of those shown on the Drawings, except for any areas authorized by the Engineer in writing.

R11 13 Payments

Payment for the construction of concrete curbs and/or channels will be made at the price tendered per linear meter for the item "Concrete Curbs", "Concrete Channels", or "Concrete Curbs and Channels", as may be applicable.

Unless otherwise specified, the price tendered per linear meter shall be understood to include payment for the furnishing of all materials and the performing of all work specified to be done, including the furnishing and placing of metal tie bars, dowel bars or the making of necessary excavation, and preparation of foundations including all materials unless otherwise provided for in the Bill of Quantities. No extra payment will be made for horizontal and vertical curved sections.

Payment for expansion joint filler material used in the transverse expansion and contraction joints in curbs and channels will be understood to be included in the price tendered per linear meter for the curbs and channels, and will not be paid for separately.

SECTION R11A

Precast concrete curbs and footway Paving slabs

R11A 01 Scope

The work covered by this Section of the Specification consists in furnishing all plant, equipment, materials and labor, and in performing all operations in connection with constructing and placing all precast concrete curbs and footway paving slabs, complete, subject to the terms and conditions of the Contract, and in strict accordance with this Section of the Specification and the applicable Drawings.

R11A 02 Materials

1. **Cement:** Portland cement shall conform to the requirements of BSI2: Part 2 (1971) Portland Cement (ordinary and Rapid Hardening) unless otherwise provided in the Special Specification of Particular Application.

2. **Aggregates:** Aggregates shall conform to the requirements of Structural Concrete Section B8, except that the requirement for grading need not apply to the coarse aggregate fraction.

3. **Mixtures:** The aggregates shall be so sized, so graded and proportioned and thoroughly mixed in a batch mixer with such proportions of cement and water as will produce a homogeneous concrete mixture of such quality that the curbs and footway paving slabs will conform to the test requirements. In no case, however, shall the ratio of aggregate to cement, by weight, be neither greater than 4 to 1 for curbs nor 3 to 1 for paving slabs.

R11A 03 Curbs

1. **Dimensions:** Precast concrete curbs shall be manufactured to the dimensions shown on the Drawings. The moulds shall be accurate in size, shape and form, and the inner surfaces shall be clean and true.

2. **Moulding:** The curbs may be made by any approved process. Where they are compacted under hydraulic pressure, the pressure employed shall be not less than 70kg/cm^2. The escape of the finer particles of cement during the process of pressing shall be prevented as far as practicable.

3. **Tolerances:** The following tolerances from the dimensions shown on the Drawings shall not be exceeded.

Length	Width	Height
±6mm	±3mm	±3mm

4. **Freedom from Defects:** All angles of the curbs with the exception of the angles resulting from the splayed or chamfered faces shall be true right angles. The arrises shall be clean and sharp. The wearing surfaces shall be true and out of winding. On being fractured, the interior of the curbs shall present a clean homogenous appearance.

5. **Volume Weight:** A sample which has been dried to constant weight at 100˚C shall not weigh less than 2,240kg/m^3.

Maturity: Curbs shall be sampled and tested in accordance with BS 340. The date of manufacture shall be stamped on one end face. No curbs shall be laid until samples from the same batch have passed the test requirements of BS 340.

7. **Laying:** The curb foundations shall be cast in-situ concrete to the sizes shown on the drawings between vertical formwork and in lengths not exceeding 10 (ten) meters and separated by expansion joints of bituminized fiberboard. (Clause R10 02(7)). The concrete shall be Class DY /20 (Table B8/5 page B8-6). The curbs shall be laid to true line and level and any curbs deviating by more than 3mm in 3m shall be broken out and relaid.

The curbs shall be laid and bedded in a layer of cement mortar not less than 12mm and not more than 30mm thickness. The cement mortar shall be composed of one part by volume of cement and two parts by volume of fine aggregate. Concrete Class DY /20 shall be used for backing and haunching curbs.

The vertical joints between curbs shall be filled with the same class of mortar as used for the bedding, pointed and cleaned with Hessian. The constituent materials for the mortar shall be accurately gauged and mixed in an approved manner. Cement mortar shall be mixed in suitable small quantities only as and when required, and any mortar which has begun to set or which has been mixed for a period of more than 30 minutes shall be rejected.

In cases where concrete backing to curbs is not possible or not shown on the Drawings, and as an alternative bonding for curbs laid on bituminous pavement base courses, an approved synthetic resin mortar may be used if directed by the Engineer's Representative after agreement on payment.

Similarly in cases where it is undesirable to break out an existing carriageway, such as curbing for temporary traffic diversions or experimental traffic islands, synthetic resin mortar may be used as an adhesive when approved by the Engineer's Representative.

When the curb foundation is acting as a haunch for bituminous pavement bases and base courses the Engineer's Representative may, at locations where rapid curbing progress is essential, authorize the curbs to be set on a ‘windrow’ of fresh concrete. This method will not be regarded as a general practice and will only be authorized provided adequate concrete strength is achieved and the cross-sectional area of the foundation exceeds the rectangular section shown on the Drawings, since it enables rapid progress because it avoids the necessity to fix side forms and eliminates the mixing and placing of the mortar bed. The approval of the use of the ‘windrow’ method of curb foundation construction will also be subject to the Contractor using suitable truck mixers to deliver the concrete, so that the foundations can be deposited straight from the delivery chute of the truck along the line of the curb and that the curbs are bedded directly therein without delay.

R11A 04 Flagstones (concrete paving slabs)

1. **Dimensions:** The flagstones shall be 50cm x 50cm x 5cm or as otherwise shown on the Drawings or as directed by the Engineer's Representative.

2. **Moulding:** The flagstones may be made by any approved process.

3. **Strength:** The flagstones when supported with the wearing surface uppermost on horizontal, hard, un-yielding bearers, each 6mm wide on the supporting surface, placed parallel to each other and 45cm apart shall support a load of 830kg for one minute after the full load has been applied without cracking. The load shall be applied to a space 5cm wide in the centre of the flagstone, extending the whole width and parallel to the bearers, and shall be applied at a uniform rate not exceeding 10kg per second.

4. **Rate of Wear:** The samples shall be dried at not more than 37°C and then tested by an apparatus which consists of two end-plates mounted on a shaft so as to form, with four samples, a rectangular drum with the samples as sides. A charge of 1000 balls of hard steel or chilled cast iron, each with a diameter of 13mm to 11mm is placed in the drum, which is then revolved for 24 hours at a regular speed of 60 R. P.M. in one direction, and a further 24 hours in the opposite direction. The wear on the faces of the samples shall be uniform, and when the faces have been dried as before and the faces brushed free of dust, the loss in weight shall not exceed 1.4kg.

5. **Absorption:** Flags shall be sampled and tested in accordance with BS 368 (Appendix C) and the result should be according to the following table:-

Age of the sample at test	Maximum average absorption by weight
Month up to	%
1	4.0
2	3.5
3	3.3
4	3.2
5	3.1
6 and over	3.0

6. **Volume Weight:** A sample, dried to a constant weight at 100°C, shall weigh not less than 2,240kg/m^3.

R11A 05 Laying footways

The foundation for the footway shall be granular sub-base (complying with Section R6) not less than 10cm thickness or as shown on the drawings. The flagstones shall be laid to true line and level and to the pattern shown on the drawings or as approved by the Engineer's Representative on a full bed of sand/cement mortar in accordance with Clause R11 A 03 (7) not less than 2cm thickness.

R11A 06 Measurement

The unit measurement will be the linear meter in place for curbs and the square meter in place for footways.

R11A 07 Payment

The unit price tendered for each linear meter of curbs and for each square meter of footways shall be full compensation for furnishing all labor, materials, tools and equipment necessary to complete the curbs and footways according to the Drawings and Specification, including the furnishing and placing of the in-situ concrete, the sub-base material and the required mortar, and such excavation as is required.

SECTION R11B

Extruded Concrete Curbing and Channel

R11B 01 Scope

The work covered by this Section of the Specification consists in furnishing all plant, equipment, materials and labor, and in performing all operations in connection with constructing and placing extruded concrete curbing or combined curbing and channel, complete, subject to the terms and conditions of the Contract, and in strict accordance with this Section of the Specification and the applicable Drawings.

R11B 02 Materials

1. **Cement:** Portland Cement shall conform to the requirements of BS 12: Part 2 (1971) Portland Cement (Ordinary and Rapid Hardening) unless otherwise provided in the Special Specification of Particular Application.

2. **Aggregates:** Aggregates shall conform to the requirements of Structural Concrete Section B8, except that the requirement for grading will depend upon both the type of extruding machine and the type of aggregate. Rounded coarse aggregates are preferable to crushed aggregates and the maximum size should not exceed 20mm with smaller sizes for auger machines. To achieve a well sealed surface the sand content will usually need to be between 45 and 55% depending upon the sand grading and type of machine.

3. **Mixtures:** The aggregates shall be so sized, so graded and proportioned and thoroughly mixed in a batch mixer with such proportions of cement and water in a mix designed to suit the extruding concrete machine and the result of trial lengths of curbing. With auger extruders the workability of the concrete shall be maintained between 3 and 15mm slump, with the slip form type of machine the slump should be within the range 2. 5 to 10cm. With all extruders strict control of workability is essential to ensure a uniform surface and a finished shape free of slumping.

Class D concrete with aggregate size to suit the extruder shall be used unless otherwise specified on the Drawing or Special Specification of Particular Application.

R11B 03 Equipment

The type of concrete extruding machine will be approved by the Engineer's Representative only after a satisfactory trial length of curbing has been constructed and the precise concrete mix, workability and machine operators of adequate skill have been approved.

Types of concrete extruding machines acceptable for trial are the screw-auger extruder (running either on rails or on a prepared surface) and the line-guided slip form extruder (fitted with paddles or vibrators for compaction.)

Rail-mounted curb extruders will not be used on radii less than 15m, for radii of 15 to 60m the track should be laid in 1·5m lengths and for over 60m radius track lengths of 3m will be accepted.

When concrete curb extruders are supplied by truck mixer, the mixer drum shall be powered by a separate engine to ensure a slow discharge rate independent of the truck speed.

11B 04 Preparation of base

Extruded curbing combined with an extruded concrete channel is of sufficient width to insert tie bars in a plastic concrete base when shown on the Drawings, out tie bars will not be used for bonding of curbing in narrow widths where the operation of the extruding machine is so affected as to result in unsatisfactory extruded concrete curbing. Any resin curing agent on concrete slabs shall be removed before the curb is extruded.

When the Drawings show an extruded concrete flush curb (beam edge) for bituminous pavements and the edge detail is used as a datum for carriageway levels, the formation must be trimmed well in advance of the extruder. In such cases the mean formation level should be lower than the design depth of the edge detail to ensure that the extruder has no problems in negotiating high spots.

R11B 05 Expansion and contraction joints

Expansion joints are required for extruded concrete curbing on concrete pavement, including steel tie bars and curing of concrete all in accordance with Section R11-Concrete curbs and Concrete Channels Cast-in-Place.

Expansion joints are formed in freshly extruded concrete minutes after laying by cutting through the edge of the curbing with a hacksaw, the extruded section being supported by metal formers placed on each side of the required position of the joint. A filler board should then be placed in position in the gap.

Contraction joints at about 15m centers are formed by a similar method to expansion joints except that the extruded curb is only cut to one-third to one-half its depth.

When using an auger extruder machine the finish should be left as extruded. In the case of wetter-mix concretes extruded by a slip form machine a brush finish may be applied if directed by the Engineer's Representative.

R11B 06 Measurement and payment

Measurement and Payment for the construction of extruded concrete curbing and/or edging will be in accordance with Section R11-Concrete Curbs and Concrete Channels Cast-in- Place.

SECTION R11C

Extruded Asphalt Curbing

R11C 01 Scope

The work covered by this Section of the Specification consists in furnishing all plant, equipment, materials and labor, and in performing all operations in connection with constructing and placing extruded asphalt curbing or combined curbing and channel, complete, subject to the terms and conditions of the Contract, and in strict accordance with this Section of the Specification and the applicable Drawings.

R11C 02 Materials

1. **Asphaltic Cement:** The asphaltic cement shall comply with the general requirements for asphaltic cement contained in Section R9 Hot Mix Asphalt Concrete Pavement.

2. **Aggregates:** Aggregates shall conform to the requirements of Materials in Section R9 Hot Mix Asphalt Concrete Pavement, except that the requirement for grading will depend upon both the type of extruding machine and the type of aggregate. The coarse aggregate should not exceed 20mm nominal size. The fine aggregate should be a sand complying with BS594 (1973) for wearing courses.

3. **Mixture:** The composition of the mix for asphalt curbing shall be determined from trials with the type of asphalt extruder it is proposed to use.

The percentage constituents of the mix shall be approximately as follows:

Asphaltic Cement: Bitumen (85-100 pen.)	6.0 to 9.0
Crushed Stone or Gravel Aggregate complying with Clause R9 02	20.0 to 35.0
Filler	10.0 to 13.0
Sand	50.0 to 58.0

Within the above limitations, the mix shall be designed by the Contractor, who shall make trial mixes of the asphaltic composition and carry out tests using the same plant as will be used in the Works to ascertain that the mixes and plant are entirely satisfactory for the work. When a proposed mix has been approved, no variations shall be made in the mix proportions or in the type, size, grading zone or source of any of the constituents without the agreement of the Engineer's Representative who may require further tests to be made.

The materials shall be weighed and measured into a mechanical mixer and thoroughly mixed so that all particles of the aggregate are completely and uniformly coated. The mixing temperature shall be such that the temperature of the mixed material laid on site shall be within the range 140˚C to 180°C.

R11C 03 Equipment

The type of asphalt automatic extruding curbing machine will be approved by the Engineer's Representative only after a satisfactory trial length of curbing has been constructed and the precise asphaltic mix, workability and machine operators of adequate skill approved.

The curbs shall be closely compacted with regular sides, edges, arrises and chamfers finished to a fine surface free from blow holes and dragging and shall be impervious. The mould to the extruding machine shall be heated if necessary and any cracks appearing in the hot curb close to the machine shall be closed with a trowel immediately after extrusion.

R11C 04 Preparation of base

The asphalt extruding machine will run directly on the base course or preferably the wearing course of asphalt concrete pavements. The surface must be clean and it may be necessary to use a tack coat as Section R8B or an approved cationic bitumen emulsion to ensure a good bond. The curbing should be laid as soon as practicable after the completion of the surface on which it is to be laid.

R11C 05 Surface regularity

Asphalt curbing shall be laid without joints. The surface regularity of the top of curbs shall comply with the requirements for the surface regularity of the pavement courses on which the curbs are laid.

The horizontal alignment shall not depart from that shown on the Drawings by more than ±3mm nor deviate from the straight by more than 3mm in 3m.

The vertical alignment of the top of the curb shall not depart from that shown on the Drawings by more than ±6mm and at any point the maximum deviation of the top of the curb under a straight edge shall not be greater than 3mm in 3m.

R11C 06 Measurement and payment

Measurement and payment for the construction of extruded asphalt curbing and/or edging will be in accordance with Section R11.