

2 MATERIALS AND COMPONENTS

2.1 General

All structural materials used in a cemetery monument shall exhibit high atmospheric-corrosion-resistant properties and have a minimum predicted service life of 50 years.

NOTE –

- (1) Most natural stone and some non-ferrous metals are considered suitable for this application.
- (2) Consideration should be given to loadings due to foot traffic on monuments.
- (3) Thermal stresses are generally the most severe stresses imposed on monuments. Allowance should be made when fixing stone elements for the likely differential movements between the stone and the substrate.

2.2 Cement

Cement shall be in accordance with NZS 3122 or NZS 3123.

2.3 Monumental material

2.3.1 *Natural stone*

The stone selected shall be sound, durable and of proven suitability, in accordance with 2.1.

NOTE –

- (1) Care should be taken to ensure, as far as possible, that the stone is free from defects likely to affect durability and structural integrity.
- (2) Limestone and cast stone made with limestone should not be used in conjunction with sandstone if water can drain from the former onto the latter.

2.3.2 *Assessment of durability*

The assessment of the predicted service life of any particular type of natural stone shall be undertaken by reference to at least one of the following:

- (a) Past performance in monumental applications or on buildings;
- (b) Mineralogical and physical characteristics of the material;
- (c) Accelerated weathering testing and comparison with materials of known performance.

2.3.3 *Minimum thickness*

2.3.3.1

Elements of thickness shown in table 2.1 are deemed to satisfy the requirements regarding thermal loads in design and construction so long as good practice is adhered to with respect to allowing end movement and to grouting and pointing procedures.

2.3.3.2

Because stone is a natural material there will be some cracking despite the best endeavours of the mason. Proper compliance with thickness requirements should ensure that not more than 3 % of monuments show signs of cracking in the first 5 years after installation.

2.3.4 *Tolerances*

The tolerance in the minimum thickness of an element shall be no greater than ± 2 mm.

2.4 Concrete

The minimum characteristic compressive strength at 28 days shall be not less than 20 MPa.

2.5 Mortar

All mortar used shall be in accordance with the requirements of NZS 4210.

Table 2.1 – Minimum stone thicknesses

Element	Minimum thickness (after polishing)	Minimum thickness for areas where further reduction in risk of cracking is required
	mm	mm
Veneers	30	40
Veneers where L:B > 5:1	40	50
Kerbs – Horizontal	50	70
– Vertical	70	70
Ledgers	50	70
Back kerbs	70	70
Ashlar kerbs	70	70

NOTE –

- (1) Back kerbs used to support headstones, structural kerbs, etc. should be sized to support the loads. This requirement is only for thermal loads and crack resistance.
- (2) It is suggested that minimum thicknesses shown for areas with higher risk of cracking be used for darker granites (red, dark grey or blacks) and for lower strength materials (e.g. marbles) in all areas. Local experience may dictate the use of even greater thickness for darker materials.
- (3) Long thin veneers and elements are more susceptible to cracking.
- (4) The minimum thickness should be increased in areas which are subject to wide variation in daily temperatures.

2.6 Dowels and cramps

2.6.1 Metal dowels

Metal dowels shall be of an alloy type that exhibits high resistance to atmospheric corrosion. Copper alloy shall be Grade 443 as specified in AS 2738.2 (also known as Admiralty brass - arsenical) and, for stainless steel, Grade 304 in accordance with AS 2837. Stainless steel shall exhibit non-magnetic qualities.

2.6.2 Other materials

This Standard does not preclude the use of materials for dowels and cramps other than those specified in this Standard, provided that such materials can be proved by appropriate performance testing to be equal to or better than metal as specified in 2.6.1.

2.7 Reinforcing steel

Except where specified elsewhere in this Standard steel reinforcement shall comply with NZS 3402, NZS 3421 and NZS 3422 where applicable.

2.8 Grouting

Pointing and grouting materials shall contain cement, or other material of equivalent durability.

2.9 Flexible compound bonding and sealing agents

The following compound types shall be considered in conjunction with the manufacturer's specifications and fitness for purpose:

- (a) Silicone in accordance with BS 5889;
- (b) Polysulphide;
- (c) Polyurethane;
- (d) Solvent release acrylic sealant.

NOTE – All sealant joints should be detailed in accordance with the manufacturer's recommendations, and incorporate an appropriate backing rod.

2.10 Gunmetal

Where nonferrous metals are used for casting of plaques, numerals and lettering, alloy C83600 shall be used as specified in AS 2738.3 (also known as leaded gunmetal).

2.11 Lettering

Where lettering, numerals, plaques or ornaments are applied or fixed to a monument, consideration shall be given to the long-term durability of the methods for fixing, finish and adhesion.

NOTE – Gold infill or paints on inscriptions should not be required to exhibit the same durability as the material on which it is used. It is recommended that 23 carat gold leaf be used for all gold lettering.

3 DESIGN AND CONSTRUCTION

3.1 General

3.1.1

All monuments shall be designed and constructed according to sound engineering principles to provide a stable monument that is durable, serviceable and which provides satisfactory performance for the life of the monument.

3.1.2

This section should be read in conjunction with Appendix A *Recommended installation practice* and Appendix B *Recommended details for cemetery monuments*.

3.2 Quality of work

Monumental work shall be done by appropriately trained personnel and shall be carried out in accordance with the requirements of the design as contained in the drawings or specifications, or both, approved by the cemetery authority.

3.3 Footings

3.3.1 General

3.3.1.1

Footings shall be designed in accordance with sound engineering principles and in accordance with NZS 3604 (Appendix E) and NZS 3101 where appropriate, having regard to the size and load imposed by the monument. Local soil conditions, foundation movement and any special performance requirements shall be considered in the design of the monument and in accordance with the principles of this Standard and any individual cemetery authority requirements.

3.3.1.2

In the absence of any cemetery authority building requirements and where satisfactory engineering computations are not submitted, the footing shall be constructed in accordance with 3.3.2 and figure 3.1.

3.3.2 Pier design

The size and depth of piers supporting footing beams for a single grave may be taken from figure 3.1, which is based on the loads resulting from any one of the following monuments:

- (a) Full-grave construction (usually less than 1 tonne, maximum 2 tonnes);
- (b) Headstone and part canopy (max. 3 tonnes);
- (c) Canopy type (max. 4 tonnes);
- (d) Other types not greater than 3 tonnes total.

Tolerances on footings and reinforcement placement shall comply with NZS 3109. Reinforcement shall be accurately located using purpose-made bar chairs, or cover spacers.

NOTE –

(1) Most normal monuments would meet the above weight restrictions. For monuments falling outside these limitations, and for soil types not listed in figure 3.1, full engineering computations should be submitted. This applies particularly to loose sands, soft clays and silts.

(2) It is recommended that 4 piers per grave be used.

(3) The main benefit gained from the use of reinforcement is improvement in the pier's capacity to resist lateral ground pressures.

3.3.3 Soil descriptions

3.3.3.1 Sands and gravels

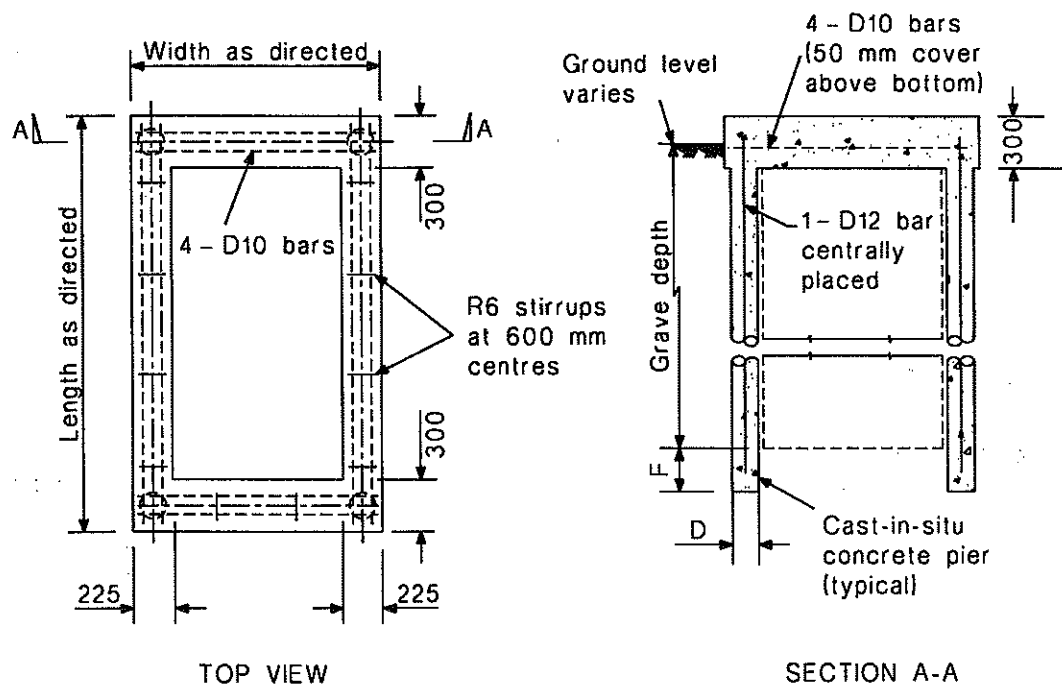
For the purposes of figure 3.1, sands and gravels shall be classified as follows:

- (a) *Medium sand or gravel.* Sand or gravel deposits removable by vigorous shovelling and into which a sharp-pointed wooden post 50 mm square can with some difficulty be driven with a hammer not exceeding 5 kg.
- (b) *Dense sand or gravel.* Sand or gravel deposits requiring picking for removal, and offering high resistance to penetration by excavating tools.

3.3.3.2 Clays

For the purposes of figure 3.1, clays shall be classified as follows:

- (a) *Firm clay.* Soil which may, with moderate effort, be penetrated to a depth of 50 mm by the thumb.
- (b) *Stiff clay.* Soil which may readily be indented by the thumb, but penetrated by the thumb only with great effort.
- (c) *Very stiff clay.* Soil which may be readily indented by the thumbnail.



The table below shows the requirements for piers and pier size.

Foundation type	Description	Weight of monument – less than 2 tonnes		Weight of monument – 2 to 3 tonnes		Weight of monument – 3 to 4 tonnes	
		D	F	D	F	D	F
Sands, gravels	Medium sand or gravel	150	*	150	100	150	600
	Dense sand or gravel	150	*	150	100	150	300
Clays	Firm	150	*	150	600	150	1200
	Stiff	No piers required	No piers required	50	200	150	400
	Very stiff to hard	No piers required	No piers required	No piers required		150	100
Rock	Highly to moderately weathered	No piers required	No piers required	No piers required		150	100

* In these soils all full-grave construction (less than 2 tonnes) requires the support and anchorage of a 600 mm deep pier at each corner.

Figure 3.1 – Minimum footing requirements

3.3.3.3 Rock

For the purposes of figure 3.1, rock shall be classified as follows:

- (a) *Highly weathered rock.* Rock of predominantly earthy colours (particularly yellows, reds and browns) with numerous clay seams, and pieces of which can generally be broken by hand;
- (b) *Moderately weathered rock.* Rock showing some earth colour predominantly surrounding the joints with some clay seams, and pieces of which can generally be broken by hand.

3.3.4 Concrete

If the concrete is mixed on site, it is suggested that specifying the mix by proportions, rather than strength, will assist in obtaining an adequate mix. For wet conditions, pumping out water immediately before pouring and the use of sleeves may be appropriate.

3.4 Dowels

3.4.1 Specification

3.4.1.1

Where dowels are used for permanent alignment of structural elements, the diameter of the dowel shall be not less than 10 mm:

Table 3.1 – Dowel sizes

Monument size	Dowel diameter	Dowel length
mm	mm	mm
Up to 900 x 600	10	140
900 x 600 to 1200 x 750	12	200
Larger than 1200 x 750	Dowel size to be determined by design engineer calculations	Dowel size to be determined by design engineer calculations

3.4.1.2

For large monuments, profiled or threaded dowels are recommended. The dowel diameter is taken at the narrowest part of the profile or the base of the thread.

3.4.1.3

The dowels may have a square cross section, minimum dimension to be equal to the dowel diameter.

3.4.2 Dowel penetration

For headstones and monuments up to 900 mm x 600 mm in size the minimum dowel penetration in each structural element shall be the lesser of:

- (a) 70 mm, or
- (b) 50 % of the thickness of the element.

3.4.3 Dowel hole

The dowel hole shall be between 1.5 and 2 times the diameter of the dowel with a minimum overall hole clearance between length of dowel and depth of hole of 9 mm.

3.4.4 Number of dowels

The number of dowels required for a memorial will depend on the size and design of the memorial and shall ensure the alignment and security of each element. For guidance:

- (a) For desk, spire, or post monuments, up to 500 mm in width, one dowel is sufficient;
- (b) For plate monuments wider than 500 mm, 2 dowels are required;
- (c) These requirements do not apply to dowels used to fix veneers to a concrete wall.

3.5 Wind loading

For high wind load areas, extra precautions in the design of monuments may be required in accordance with NZS 4203.

3.6 Thermal and other loads

Due allowance shall be made for thermal and other loads when designing and constructing monuments.

3.7 Renovation of monuments

Where renovation work is to be performed on a monument, such work shall be carried out in accordance with this Standard, provided that where existing details have performed satisfactorily, such details shall be deemed to be in accordance with the Standard.

APPENDIX A
RECOMMENDED INSTALLATION PRACTICE
(Informative)

A1 SCOPE

This Appendix deals with methods that have been adopted in the handling, transportation and erection of individual monumental components.

A2 HANDLING

A2.1 Packing

Monumental components should be packed prior to loading at the factory in which they were manufactured, to avoid damage while in transit to the cemetery or place of storage.

A2.2 Unloading

Monumental components should be unloaded from the truck either by truck crane or by hand with the use of skids affixed to the truck. Each component is then placed on a hand-propelled unit directly from the truck and transported to the grave site.

NOTE – In certain circumstances the truck crane can unload the monumental components directly onto the grave foundations.

A3 ERECTION

A3.1 Footings

In the absence of any cemetery authority requirements, the footings should be constructed in accordance with 3.3 and figure 3.1.

NOTE – For drainage purposes there should be a fall of 1 in 100 from the head to the foot of the grave.

A3.2 Ashlar

Where ashlar is required it should be prefixed, squared and allowed to set before any monumental component is erected thereon.

A3.3 Kerbs

Kerbing stones are set up and squared on previously placed ashlar, or directly onto the concrete footings where no ashlar exists. Kerbs are fully grouted and bedded. The ledger, back kerb, pillars and headstone are then fixed into place.

A3.4 Ledger support for full-grave construction

The ledger is supported on concrete which is poured over the post-burial grave mound and is contained between the kerbs of the grave.

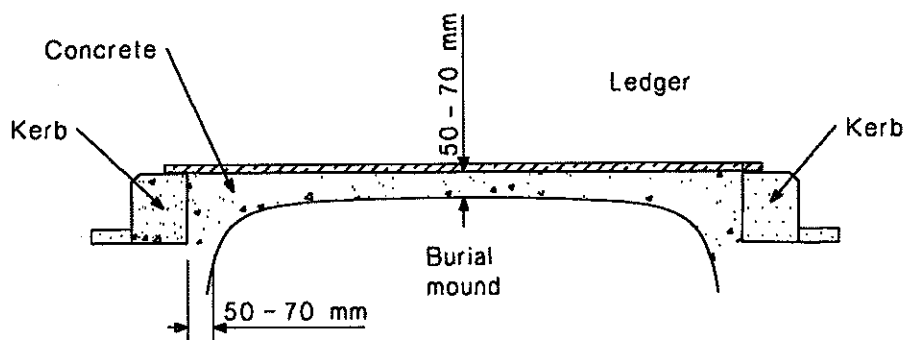


Figure A1 - Ledger support

A4 DOWEL INSTALLATION

To guarantee the complete mortar cover of the dowel, the procedure during installing is as follows:

- (a) Clean the dowel hole of dust and flush out before the mortar is inserted;
- (b) Mortar the dowels into the headstone after pre-wetting of the dowel holes. Excess water in the mortar needs to be removed to reduce shrinkage to a minimum during the hardening of the mortar.
- (c) Pre-wet the base joints where the mortar is used and the dowel holes in the footing or base;
- (d) Insert mortar into the dowel holes in the footing or base. Good plasticity of the mortar ensures a complete cover of the dowel;
- (e) Spread the mortar on the base joint surface;
- (f) Place joint spacers. Lead or plastic spacer plates are acceptable. Timber wedges should be avoided as they cause a weakening of the mortar bond due to the influence of moisture in the timber.
- (g) Lower or place the headstone onto its base or footing;
- (h) Do not loosen the headstone after the initial set of the mortar;
- (i) Remove excess mortar.

NOTE –

- (1) Mortaring of the dowel into small monuments can be done in the workshop whereas on larger monuments the installation of the dowel on site is usual.
- (2) Adhesion between the dowel surface and the mortar can be increased dramatically by spreading both ends of the dowel or by profiling the dowel surface incorporating notching or burrs in the opposite direction to the tensile forces. To increase adhesion between the dowel hole surface and the mortar, roughening of the hole is adopted.

A5 WALKING LEDGERS

To help avoid ledgers moving on the top of monuments due to the expanding and contracting of the granite during temperature changes, it is recommended that small pieces of lead approximately 20 mm square be spaced between the ledger and the kerbs prior to the pointing up of the memorial.

APPENDIX B
RECOMMENDED DETAILS FOR CEMETERY MONUMENTS
 (Informative)

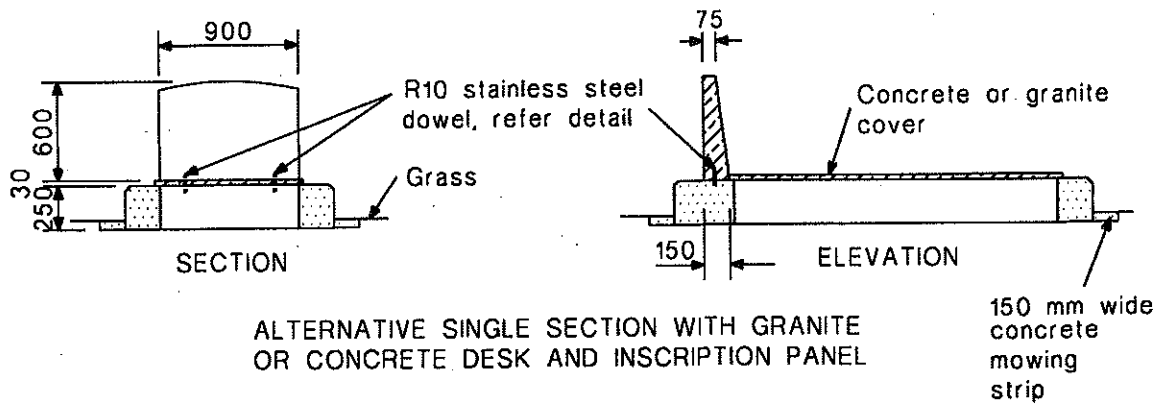
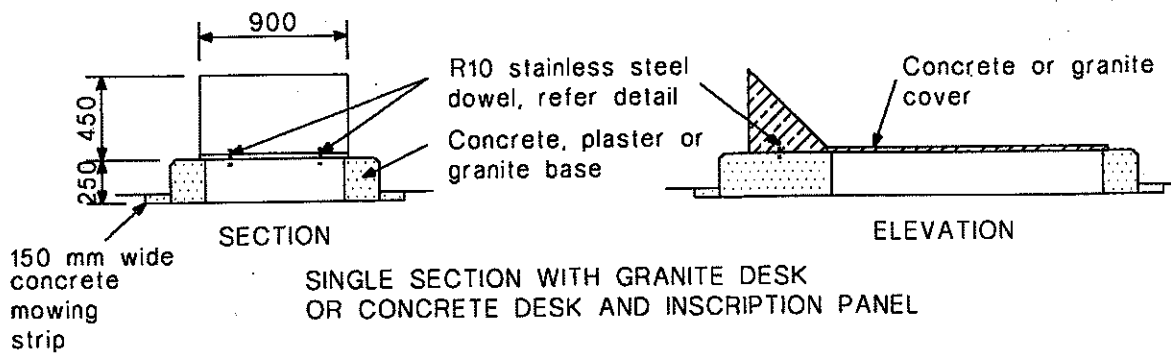
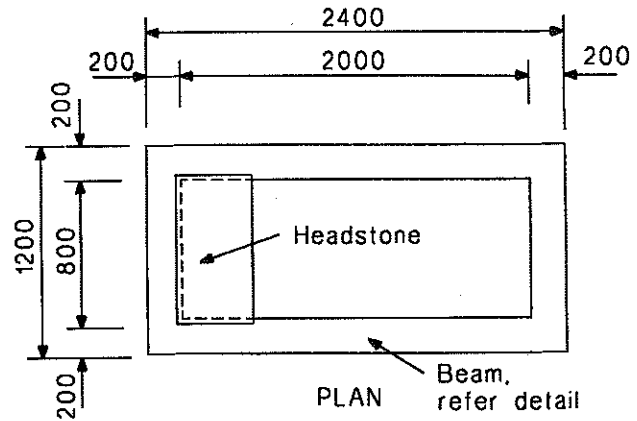
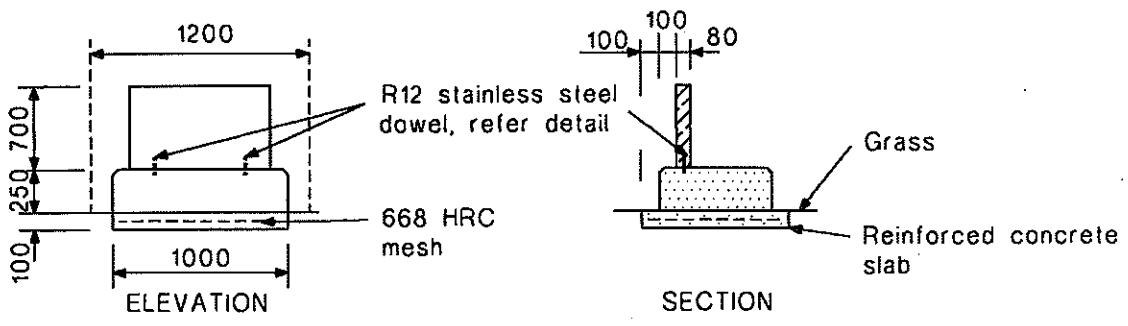
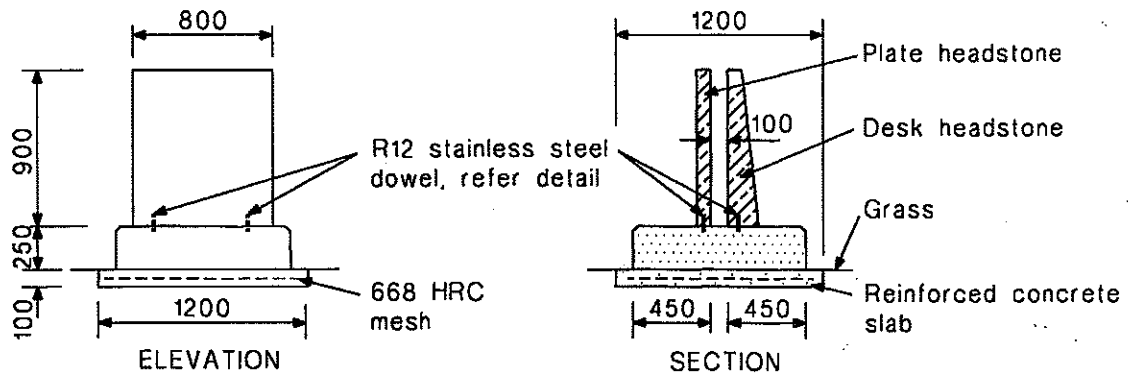


Figure B1 – Single section full-grave monument



STANDARD SINGLE BERM - SUITABLE FOR DESK OR BERM MONUMENT



STANDARD DOUBLE BERM

Figure B2 – Single section lawn headstones and berm monuments

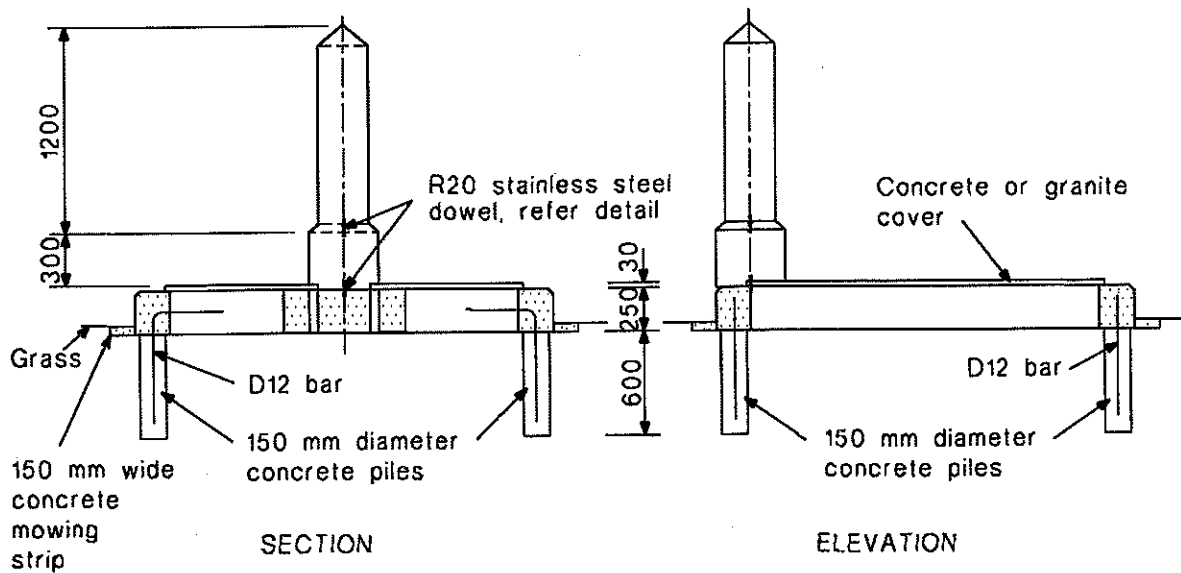
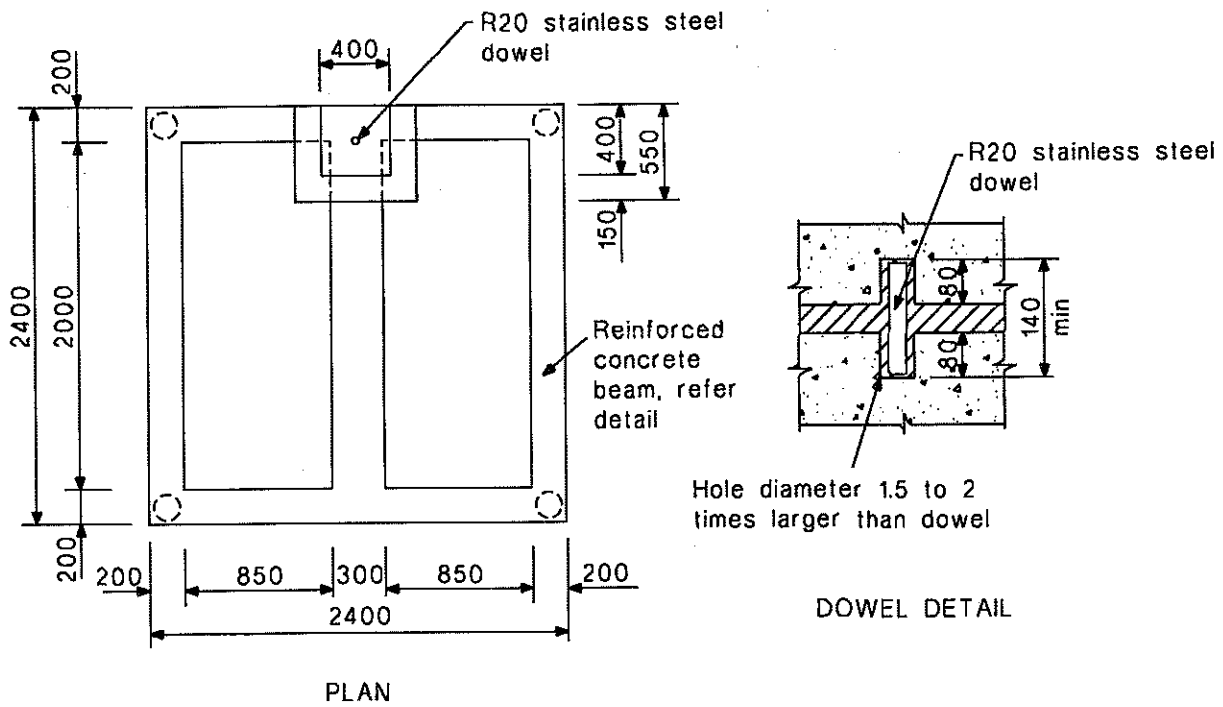


Figure B3 – Double section post monument and base

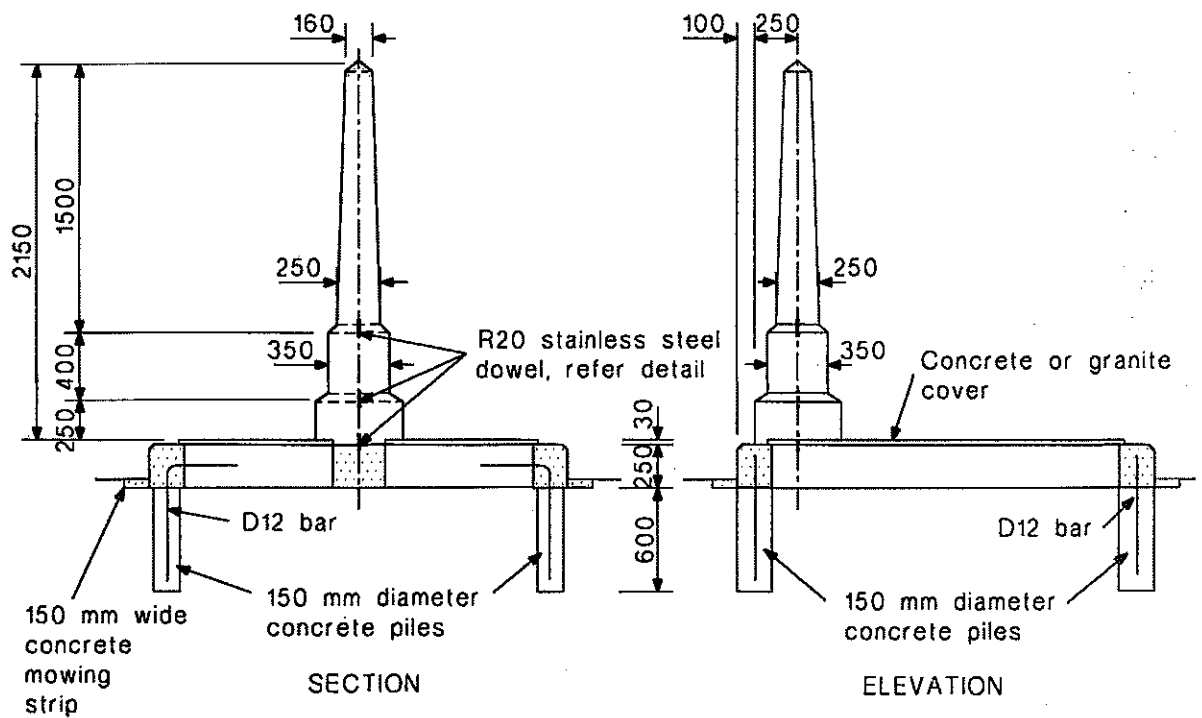
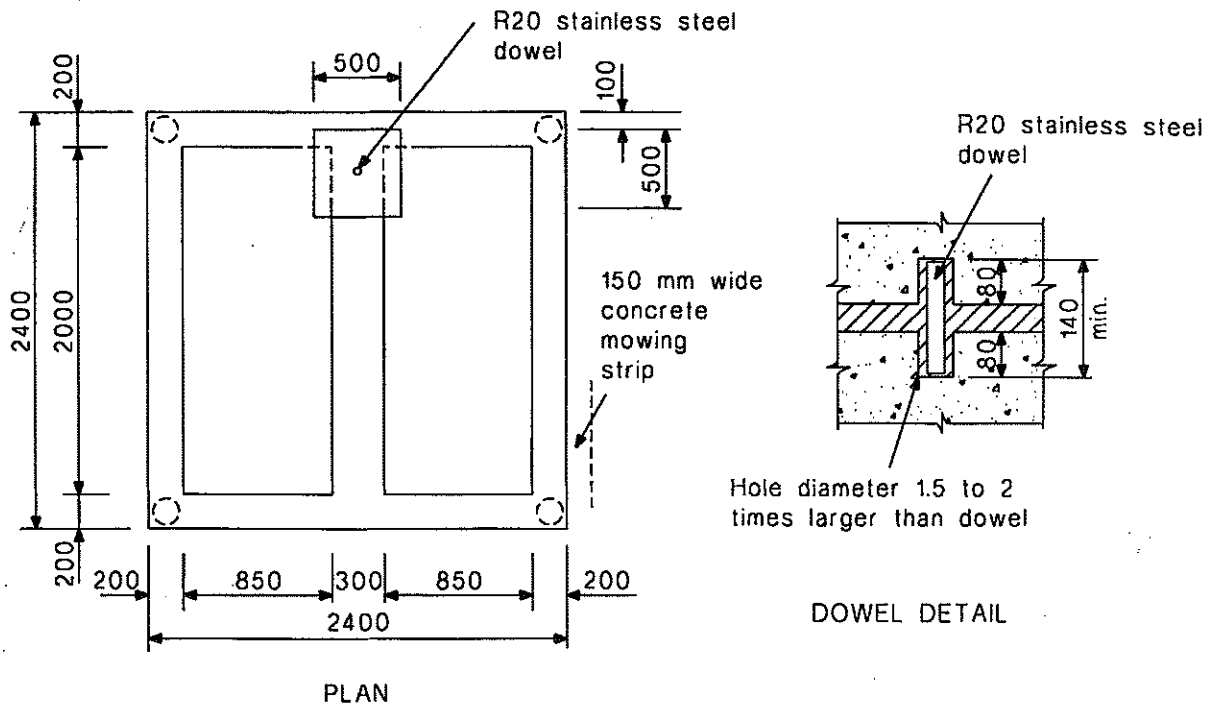


Figure B4 – Double section spire monument and base