1.4 Mortar and Mortar Joints

Summary of Requirements

Mortar					
Minimum Strength:	12.5 MPa at 28 days for structural masonry.				
Minimum Bond Strength:	200 kPa at 7 days for non-structural veneer.				
Durability:	***M4 Exposed/Coastal***	Cement 1 part	: Lime 0-0.25 part	: Sand 3 parts	
	M3 Exterior/Inland	Cement 1 part	: Lime 0.50 part	: Sand 4 parts	
	M2 Interior	Cement 1 part	: Lime 1 part	: Sand 6 parts	
	Admixture complying with AS 1478 can replace lime.				
Sand:	To comply with *NZS 3103 Specification for sands for mortars and plasters*, Class A.				
	The sand should not contain more than 0.04% of chloride by dry weight of sand.				
Cement:	To comply with *NZS 3122 Specification for Portland and blended cements (General and special purpose).*				
Water:	To comply with *NZS 3121 Specification for water and aggregate for concrete.*				
Pigment:	Dosage not to exceed 3% dry weight of cement.				
Pre-bagged products of Dry Mortar meeting these requirements are available from Cemix Limited and Dricon.					

Joints	
Nominal Thickness:	10 mm.
Tolerance:	± 3 mm.
Bottom Joint:	May vary in thickness from 7 mm to maximum of 20 mm to accommodate foundation/floor tolerances.
Tooling:	Maximum depth 6 mm.

Introduction

Masonry units are usually bonded together by laying and bedding the units in Portland cement mortar. The thickness of the mortar joint is part of the modular system of blockwork. There are some patent mortarless systems available overseas.

The nominal bedding joint thickness for concrete masonry is 10 mm.

The pliable nature of mortar also resolves problems such as could occur where adjacent units are of different types and possibly of differing moulds. *AS/NZS 4455 Part 1 Masonry units, pavers, flags and segmental retaining wall units - Masonry units* allows a manufacturing tolerance of ± 3 mm in unit height dimensions so it is feasible that a unit of one type could be a little higher or lower than a unit of another type. This variance can be accommodated by mortar joints. Mortarless systems require units to be manufactured to a significantly higher degree of dimensional accuracy.

New Zealand Building Code

The New Zealand Building Code sets out requirements or both structural masonry and veneer construction. The materials and workmanship

aspects of these two strands of masonry are covered by the New Zealand Standard *NZS 4210 Masonry Construction: Materials and Workmanship*.

Section 2.2 of this Standard sets out the various requirements for materials and workmanship for mortar and mortar joints.

Requirements for weathertightness are directly found within the *New Zealand Building Code E2 AS1 and AS3*. This issue is discussed further in Section 2.2 of this Manual.

Materials

Cement used in masonry mortars shall be Portland cement complying with *NZS 3122 Specification for Portland and blended cements (General and special purpose)*. Lime shall comply with BS 890 (Building limes), but may be replaced wholly or partially by admixtures provided the strength requirement will be maintained and the bond between units will not be impaired. It is important that a full understanding of admixtures and their effects should be gained before they are used. Tests should be carried out to check that the nominated admixture does not reduce the quality of the mortar and that the required compressive and bond strengths can be obtained.

More than one type of admixture should never be used together unless such usage has been proved to be compatible. Sands for mortars are specified in *NZS 3103 Specification for sands for mortars and plasters* and are defined therein as Class A which requires that 100% passes a.4.75 mm test sieve. Particle size distribution, particle shape and texture are controlled by a sand flow test as set out in *NZS 3111 Methods of test for water and aggregate for concrete*. Provision is made in *NZS 3103* for service records of sands to be kept and to be the basis of automatic approval of those sands recorded as being of the required standard.

In practice, each mortar sand has its own characteristics which influence the precise proportions used in mortar mixes. A well-graded sand may be used in larger proportions than otherwise. Experience is the best guide to a good mortar sand, but if there is any doubt it is suggested that advice be sought from a block manufacturer or licensed mason.

The presence of chloride salts from the use of unwashed beach sand can cause corrosion of ties and contribute to salt deposits appearing on the wall surface.

BRANZ recommendations are that 0.04% of dry weight of sand is the maximum level to be tolerated.

Water for mixing mortar should be clean, potable and comply with *NZS 3121 Specification for water and aggregate for concrete.*

Mortars may be coloured by adding liquid or powder pigment during mixing. A suitable pigment must maintain colour fastness under sunlight, be chemically stable in the alkalinity produced by the cement and have no detrimental effect on the setting time, permeability, workability or strength requirements of the mortar. Pigment should be added at a rate not exceeding 3% by weight of cement unless it can be shown that the increased concentrations have no detrimental effect on the bond strengths of the mortar, the maximum permitted dosage being 6%.

Mortar Mixes

The sand/cement ratio of satisfactory mortar is influenced by the characteristics of the sand and by the service requirements of the mortar. It is accordingly difficult to pre-specify the exact sand/cement ratios for masonry mortars. Acceptable mortar mixes, therefore, usually result from considerable experience on the part of the concrete blocklayer; and supported and proved by standard tests and performance in service.

The following mortar mixes are given as a guide to sand/cement ratios, by volume:

Durability	Portland Cement	Hydrated Lime*	Mortar Sand
M4 Very High	1	0-0.25	3.0
M3 High	1	0.5	4.5
M2 Medium	1	1	6.0

* Where lime is replaced by a patent admixture it is important that such admixture be used in strict accordance with the supplier's instructions and that it would allow the mortar to attain its strength and bond requirements.

It should be noted that mortar ingredients are usually measured by volume rather than by weight. In order that consistency may be achieved it is recommended that accurate gauging boxes or buckets be used in preference to shovels or spades.

The importance of proper proportioning of all mortar materials cannot be over-emphasised. Over-dosing with any material could cause problems such as colour variation, cracking, absorption and reduced bond strength.

Compressive strength of the mortar in structural masonry should be at least 12.5 MPa at 28 days and the masonry to mortar bond should be 200 KPa at 7 days.

Generally the compressive strength of mortar should be less than the strength of the units it is bonding together. The general strength requirement for concrete masonry units is 14 MPa.

The bond strength is of limited interest for structural masonry where reinforcing steel and grout provide the primary bonding. However in unreinforced veneer adequate bond strengths are necessary since it is this property that transfers loads of wind and earthquake to the wall ties, i.e. the bond strength is more important than compressive strength.

Typical values of bond strengths on concrete bricks are included in the Veneer Section (5.3).

The water retention test which relates to the loss of water from the wet mortar to the unit may be requested although a practical on-site test can be performed as follows:

(a) Mortar two bricks together to correct joint width, strike off mortar and wait two minutes.

(b) Lift the couplet by the top brick to a convenient height, usually waist height, turning the couplet over so that the lower brick becomes the top brick.

(c) The couplet is then lowered holding the new top brick.

(d) The couplet should not part during this test.

If after adjustment to the mortar mix or dampening of bricks, the test still cannot be performed, then the invoking of a full test to ASTM C91 may be required.

NZS 4210 Masonry construction: Materials and workmanship describes sample procedures for the compressive strength tests in Appendix 2A and for the bond test in Appendix 2B (referencing AS 3700). Reference should be made to that document for the details.

It is very important that having followed the procedures laid down for sampling and making specimens of mortar, that correct curing of these specimens is undertaken otherwise misleading results will be produced.

The standard curing regime for mortar strength specimens is shown in the *CCANZ Information Bulletin 51 Taking Test Cylinders on Site*.

Mixing

Mortar materials should be thoroughly mixed to an even consistency in a mechanical mixer. Paddle type mixers are preferable, although tilting-drum mixers may be used provided the blades have been adapted to produce the churning effect of a paddle mixer. Mixing time should be at least five minutes.

For small qualities of mortar, e.g. three or four buckets not exceeding 0.03 m, hand-mixing may be used provided full-mixing and blending is achieved.

Generally, mortar not used within 1½ hours should be discarded unless special provisions have been made.

Mortar may be retempered by the addition of water and thorough remixing providing that such mortar is used within the 1½ hour prescribed period from the initial mixing of the mortar, i.e. retempering does not extend the life of the mortar beyond 1½ hours.

Joint Types

Figure 1 (page 4) shows some of the tooling details commonly practiced. Some are not recommended for external application because of their poorer weatherproofing properties, but this will be of lesser significance where cavity protects the inner wall.

Because of the positive barrier to ingress of moisture any of the joint details illustrated in Figure 1 may be applied to external cavity or veneer walls without risk to inside finishes.

Of the details shown, types A, B and C are suitable for internal or external use. Raked and extruded joints should not be used externally except in cavity or veneer construction. The flush joint is recommended only for walls which received a later applied finish or coating.

The joints A, B and C, should only be tooled to a maximum depth of 6 mm after initial stiffening has occurred. The delaying of the tooling operation is vital if a tight weatherproof joint is to be produced in horizontal and, particularly, vertical joints.

Figure 2 (page 4) illustrates in an exaggerated way what is happening in the joint and how tooling gives an improved weathertightness. The whole matter of the tooling of external joints is of paramount importance and strict attention to delaying the operation after initial set of the mortar must be given.

Further details of tooling are discussed in Section 1.5 Blocklaying and under Section 2.2 Weather Resistance.

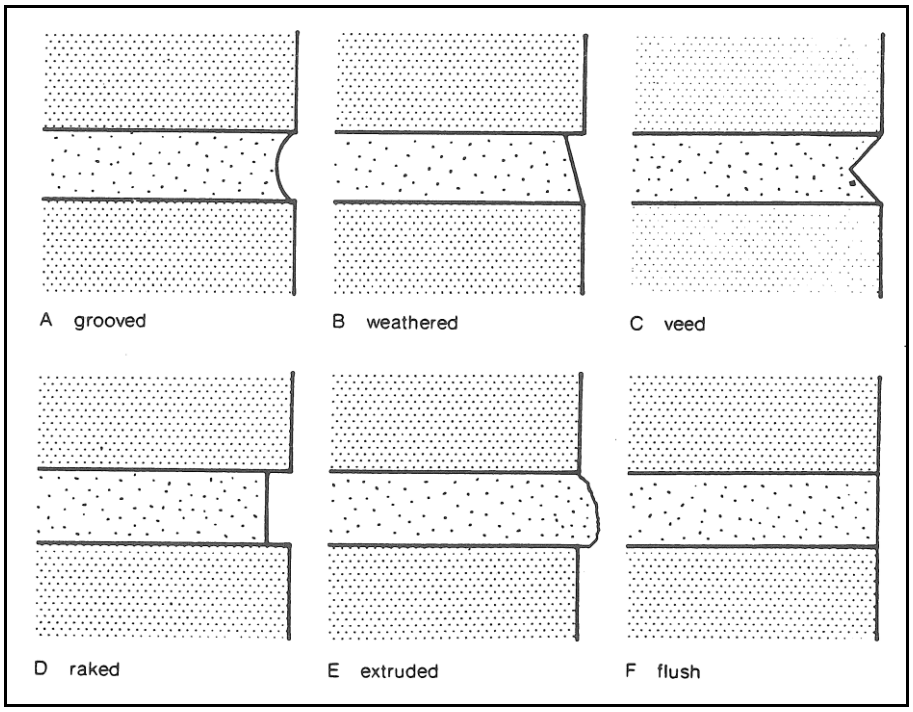

Figure 1: Joint Types

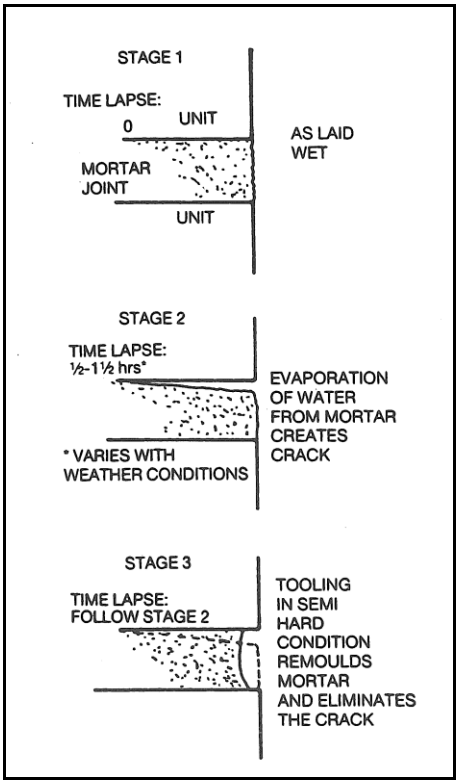

Figure 2: Tooling of Joints