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Assessment criteria

Directory of certificates

SUPPLEMENT TO CERTIFICATES:

GOOD BUILDING PRACTICE
Revised 2001

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CSIR Building and Construction Technology

South African Bureau of Standards

Contents

PREFACE

SABS 0400: 1990, *The application of the National Building Regulations*

National Home Builders Registration Council, Ferndale, South Africa. February 1999, *Home building manual, Part 3, Construction standards. Revision 1*

The certificates issued by Agrément South Africa cover innovations in the construction field which are not fully covered by the deemed-to-satisfy rules set out in SABS 0400 or by the standards and codes of practice issued by the South African Bureau of Standards, which deal with conventional materials and construction.

In compiling this *Supplement to certificates*, cognisance has been taken of the National Home Builders Registration Council's manual.

While Agrément South Africa has performance criteria for various categories of innovative construction, it has developed an almost complete set of criteria for building systems. Before an Agrément certificate for a building system is issued, a thorough investigation is carried out, usually with the assistance of CSIR Building and Construction Technology and others to ensure that the building system submitted for certification meets these criteria.

In addition to their innovative features, most building systems covered by Agrément certificates also consist of conventional forms of construction on which no specific comments are made in the certificate. The success of the system will depend on the correct design and construction of the innovative parts, covered by the certificate, as well as the conventional parts of the building. The innovative features of some building systems impose special requirements on the conventional aspects of construction, for example, building tolerances. When special requirements are necessary, they are dealt with specifically in the certificate.

Agrément South Africa expects that the relevant deemed-to-satisfy rules of SABS 0400 will be applied to the conventional aspects of the construction. In this *Supplement* it lists certain design and construction requirements which are regarded as good building practice but which are not fully covered by SABS 0400. These requirements which are displayed **bold** and in a box are considered as mandatory conditions of certification and must be complied with, where relevant to the certificated building system.

This *Supplement* also contains information and recommendations which are not conditions of certification but the use of which will improve the performance and durability of buildings.

The *Supplement* is applicable to building systems and does not apply to building or construction products, such as bridge deck expansion joints or bituminous road construction products.

ACCURACY IN BUILDING

It is not practical to expect the setting-out and finished dimensions of any building to match exactly the dimensions on the drawings.

Tolerances (plus or minus) must be accepted, but must be small enough that modular units, such as concrete blocks, wall panels, windows and door frames, can be assembled safely, correctly and without excessive cutting or trimming, in such a way that the complete structure is satisfactory.

SABS 0155: 1980, *Accuracy in buildings*

Allowable tolerances are set out in SABS 0155. The code lists three grades of accuracy, but Grade II is the most commonly used on building sites and shall be adhered to unless other tolerances are specified. Some typical examples of the Permissible Deviation (PD) allowed in Grade II masonry work are given below.

Permissible deviation (PD) allowed in Grade II masonry work

Description		PD (mm)
Position on plan of fair-faced side of wall		± 15
Length	0 - 5 m	± 15
	5 - 10 m	± 20
	over 10 m	± 25
Height	0 - 3 m (brickwork)	± 10
	0 - 3 m (blockwork)	± 15
	3 - 6 m	± 20
	over 6 m	± 25
Verticality	in any 8 courses of brickwork	± 10
	in any 3 m	± 15
Floor levels	any point under a 3 m straight edge placed level, in any direction	6 max
Finished wall surfaces: any point from a 2 m straight edge placed in any direction on the wall		6

Similar tolerances are specified for other elements of the building. With careful setting-out and good workmanship it is not difficult to remain within the limits set.

Where specific tolerances for the assembly of the system are prescribed, the setting-out and construction of all associated in-situ work must not exceed these tolerances.

Equipment used for setting-out and checking of finished work must be kept in good condition and calibrated regularly where necessary. This applies to such items as measuring tapes, straight edges, spirit levels, gauge rods, plumb bobs, levels and theodolites.

QUALITY MANAGEMENT

SABS ISO 9000: 2000, *Quality management systems - fundamentals and vocabulary*

SABS ISO 9001: 2000, *Quality management systems - requirements*

SABS ISO 9004:2000, *Quality management systems - guidelines for performance improvements*

A requirement for certification by Agrément South Africa is that each certificate holder has a quality assurance system in place, which must deal with manufacture, storage, installation or erection (whichever is applicable). This system must be based on the recommendations of the SABS ISO 9000 series. The quality assurance system must cover the innovative as well as the conventional aspects of the building system and is subject to approval by Agrément South Africa.

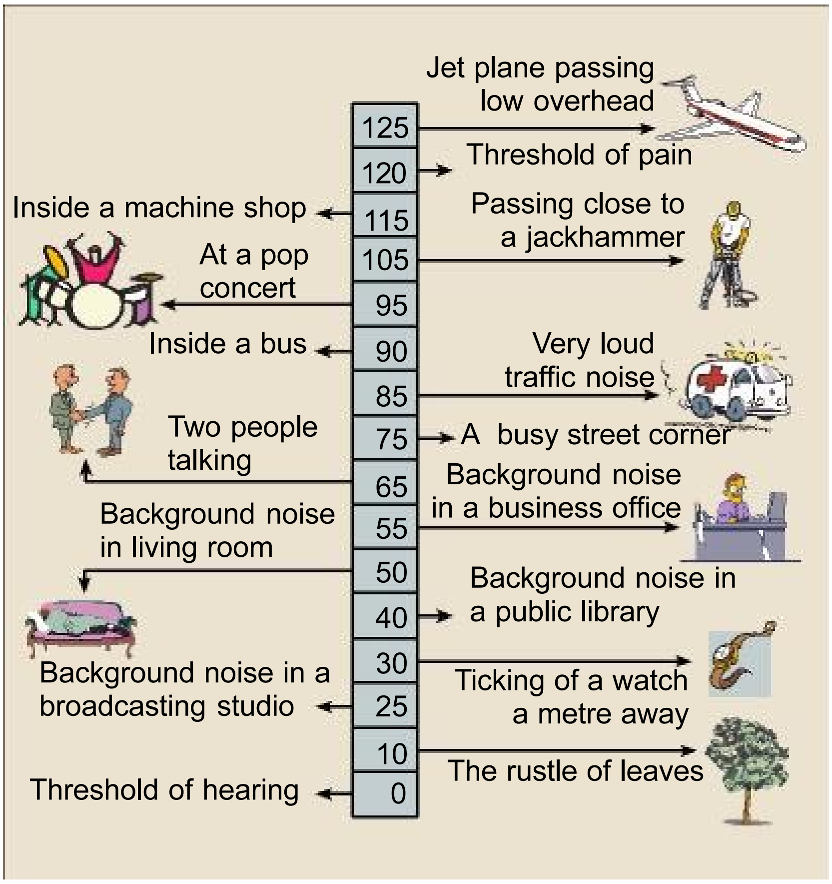
In cases where the certificate holder is listed as a manufacturer of assessed capability, Agrément quality requirements are deemed to have been met, as regards the manufacture of the product, for as long as the listing remains in force.

Even a manufacturer of assessed capability must have a quality assurance system for erection or installation on site, which has been approved by Agrément South Africa.

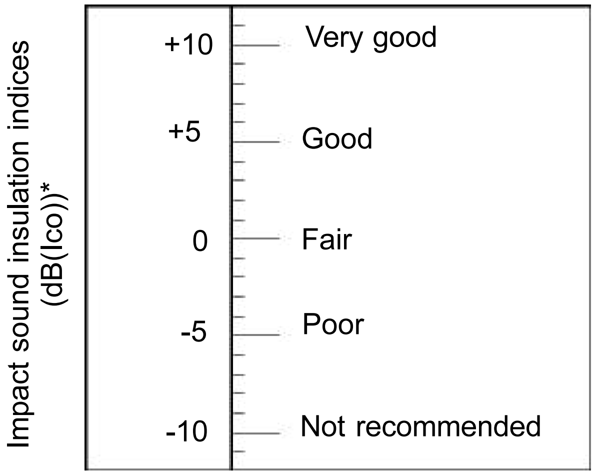
ACOUSTIC PERFORMANCE

Differing building layouts, materials and workmanship will have an influence on noise levels in buildings, partly because sound waves do not always travel in straight lines like light, but can travel around objects; and partly because the unit of sound intensity (loudness) does not increase proportionally like units of length, area or volume.

The real physical unit of sound pressure is the pascal, and sound pressure levels given in dB or dBA are actually expressing twenty times the logarithm (to the base 10) of a ratio between the alternating sound pressure under discussion, and the universally accepted reference sound pressure of 2×10^{-5} pascal, which is just audible at 1000 hertz with normal hearing. There are valid acoustical reasons for this complication. The alternating air pressure of sound waves actuates the eardrum. The ratio between the audibility threshold (2×10^{-5} or 20×10^{-6} pascal) and the pain threshold (20 pascal) is 1 to 1 000 000. This wide range is cumbersome and does not effectively interpret the loudness of a sound because of the nature of human hearing - a doubling of the sound pressure does not necessarily make the sound subjectively twice as loud. By converting the pressure scale to a logarithmic one the range of readings can be reduced to about 100, from 20 dBA for a watch ticking to 125 dBA for a jet plane low overhead (dBA is a dB measurement modified to allow for the varying sensitivity of the human ear). On the dB scale an increase of 6 to 10 dB represents a doubling in the loudness to the ear. **The chart below** gives an idea of the dB readings we would get from various day-to-day noises.



The acoustics requirements of Agrément South Africa do not cater for the provision of very high quality to satisfy the majority of people even under extreme conditions. They should rather be seen as requirements to promote a modest degree of acoustical performance, but where it is accepted that economic considerations will somehow negatively affect the intended function of a facility. **The figure below** shows the relation between airborne sound insulation and acoustic privacy between adjacent rooms.



In situ airbaorne sound insulation and acoustic privacy

In cases where there are particular acoustic requirements, the designer or owner of the building should make use of the guidance available in SABS 0218-1: 1999 and should consult an acoustics expert for advice.

SABS 0218-1:1988, *Acoustical properties of buildings Part 1: grading criteria for the airborne sound insulation properties of buildings*

Walls and floors must as far as possible be free of openings which allow the passage of sound without lessening its intensity.

Fittings recessed into the wall, such as switch boxes, distribution boards and medicine cabinets, will reduce the acoustic performance of the wall, particularly if they are placed back-to-back in the wall.

Openings through suspended floors for services should be sealed after installation of the services, both to reduce sound transfer and for fire control purposes. (The sealing should be of such a material that it can be safely removed and later replaced without difficulty, when replacement of or alteration to the services is necessary.)

Where ceilings are not provided in a building, the internal partition walls must be taken up to the underside of and sealed to the roof covering material.

Where the acoustic performance of external walls containing doors, windows, ventilation ducts, etc is important, guidance is available in SABS 0218; Part 1.

It is, however, highly advisable to seek professional advice on the design and location of the openings to ensure that these recommendations can be met.

BEHAVIOUR IN RELATION TO FIRE

Buildings must be designed, constructed and maintained in accordance with the National Building Regulations, which are intended to ensure that, in the event of fire:-

- **occupants can escape easily, quickly and safely from the building**
- **the risk of fire spread to other buildings is minimized**
- **there is adequate and appropriate fire-fighting equipment available**
- **access routes to and around the building are suitable for fire-fighting and rescue vehicles.**

Attention must be given to the following aspects of construction which are critical for fire safety:

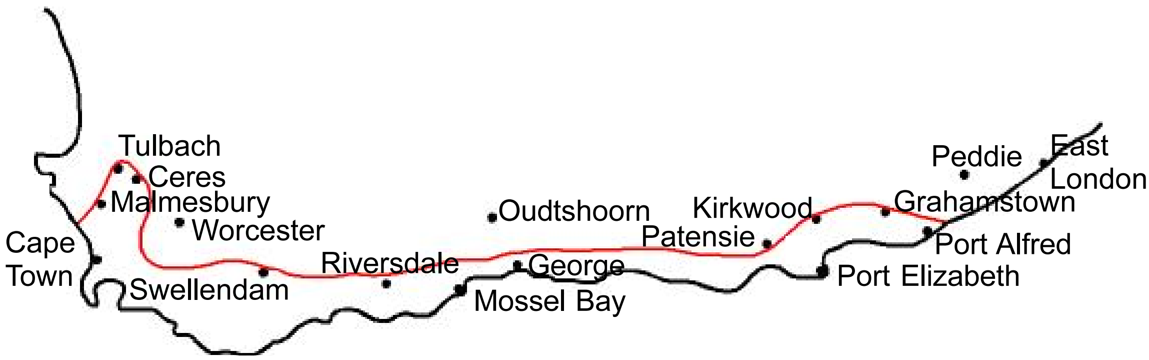
- **firewalls are to extend up to the underside of roof coverings**
- **gaps, if any, between the tops of firewalls and the underside of roof coverings are to be caulked with fire resistant material**
- **gaps around services which perforate walls with specified fire resistance ratings must be effectively sealed with a suitable sealant**
- **expansion and shrinkage joints, which occur in walls having specified fire resistance ratings, must be sealed with a suitable fire resistant sealant.**

THERMAL PERFORMANCE

The thermal performance of any building in South Africa is influenced mainly by its design and orientation. Proper attention to wall and roof insulation, window sizes, shading and orientation can produce a building which is cool in summer and warm in winter, and which will require the minimum of artificial cooling or heating.

CSIR Building and Construction Technology, BOU/E9601: 1996, *Domestic roof insulation*

Climatic conditions and sun angles vary widely in South Africa, but generally buildings should be designed to have the shorter sides and smaller windows on the east and west elevations. Most well-built conventional walls will have reasonable thermal properties, but conventional roof construction, even when ceilings are installed, has a poor thermal performance and the provision of insulation above the ceiling is very desirable in most of the country and strongly recommended in the Southern Coastal Condensation Problem Area (**SCCP Area**). More information regarding roof insulation may be found in the CSIR Building and Construction Technology publication *Domestic roof insulation*.



Southern Coastal Condensation Problem Area

Thermal comfort

As mentioned above, buildings should be so oriented that their long axes run as near east/west as possible and the east and west facing walls should be as short as is practical.

Glazing on the east and west faces should be restricted to the minimum required for functional design purposes, and large glazed areas on southern faces should be avoided if possible.

Where it is not possible to follow these recommendations because of site factors or design considerations, some form of permanent shading should be considered for glazed areas facing more than 30 ° from true north. This can be provided by extended roof overhangs, fixed or movable sun screens, or moveable shutters.

Ceiling insulation as described on page 10 has been proved to be one of the most cost-effective ways of providing a warmer building in winter and a cooler building in summer.

Condensation and the Southern Coastal Condensation Problem Area

Condensation in dwellings is a widespread problem in the Southern Coastal Condensation Problem Area because of the wet winters. Windows tend to be kept shut to keep the cold out and for security reasons, the rain produces high humidity levels, and the combination results in heavy moisture loads within the building, which are augmented by domestic activities. These high moisture loads cause condensation to form on windows and other cold surfaces, such as inner roof surfaces and walls.

Water vapour and condensation

The air in a building holds varying quantities of water vapour, depending on the amounts of water introduced into the building by humid rainy conditions, domestic activities such as cooking, washing and bathing, the number of people occupying the building, and the temperature of the air. Warm air can hold more water vapour than cold air.

The amount of water vapour in the air is usually defined as its relative humidity (RH), which is the ratio of the actual amount of water in the air at a given temperature to the maximum amount of water which the air could contain at that temperature. When the air is saturated and can accept no more moisture, the relative humidity is 100 %.

As moist air cools down, its RH increases until it reaches saturation at a temperature called the dew point temperature. When this occurs in a building moisture will start to condense on any surface at or below this temperature. The surface will thus become wet. Window glass and cold south-facing walls are generally affected first.

Adan, O C G: December 1994, *On the fungal defacement of interior finishes*. PhD dissertation, Eindhoven University of Technology, Netherlands

Mould growth is encouraged on wall and other surfaces which are sufficiently damp. Sufficient dampness usually occurs when the time of wetness exceeds 50 %, ie if the wall is wet for longer than when it is dry, for any extended period. Ingress of water into walls resulting from rain penetration, leaking pipes or repeated splashing not only increases the dampness of walls but also increases the thermal conductivity of the wall. This in turn results in colder walls and therefore more condensation.

To prevent or reduce the incidence of condensation, the inside air should be kept as dry as possible and the inside wall and ceiling surfaces as warm as possible. The following measures are recommended:

- provide permanent ventilation openings which are burglar-proof
- ensure that opening windows are effectively burglar-proofed to allow them to be left open at night when the dwelling is occupied.

Dwellings in the SCCP area with horizontal ceilings

(Map of the SCCP Area - see page 8)

In dwellings with a roof covering of metal of fibre-cement sheeting or other roofing material on an impermeable underlay and with horizontal ceilings, it is recommended that ceiling insulation be installed. Adequate roof ventilation should be provided.

The ceiling insulation should, for example, be a mineral fibre quilt at least 40 mm thick, or any other approved insulation material with an equivalent thermal resistance. It should cover the ceiling completely without gaps, to prevent cold-bridging.

For roofs at a pitch of 6° or less, a vapour barrier should be installed in addition to the ceiling insulation. The vapour barrier may be a plastic sheet, complying with **SABS 952** or approved for this use by Agrément South Africa, which should be installed immediately above the ceiling. The barrier should be fixed to the underside of the brandering or ceiling members before the ceiling itself is installed and should extend all the way to the walls. All joints should be lapped at least 100 mm and should be sealed. Openings for light fittings, conduits, pipes, etc. which penetrate the barrier should be properly sealed as well.

SABS 952:1985, Polyolefin film for damp- and waterproofing in buildings

The roof ventilation should be positioned in the soffit and eaves closers, or in the beam filling, or in the gable walls, so as to provide cross ventilation. The openings should have bird- and rodent-proofing over them. Ventilation openings in gables should also be designed to prevent rain ingress. In roofs with a pitch of 15° or less the roof ventilation should have a total area equivalent to a 25 mm wide slot running the full length of the external walls. In roofs with a pitch exceeding 15° the openings should have a total area equivalent to a similar 10 mm wide slot.

Vapour flue

It is recommended that dwellings in the SCCP Area with flat or low-pitched roofs should be provided with a vapour flue at least 150 mm in diameter or another vapour extraction device, positioned over the cooker in the kitchen.

DURABILITY AND SERVICEABILITY

Provided that good quality materials are used in a building and that the building is regularly and adequately maintained, its durability and useful life depend mainly on the workmanship put into its construction. The quality of the end product depends greatly on the application of an appropriate quality system for the building process.

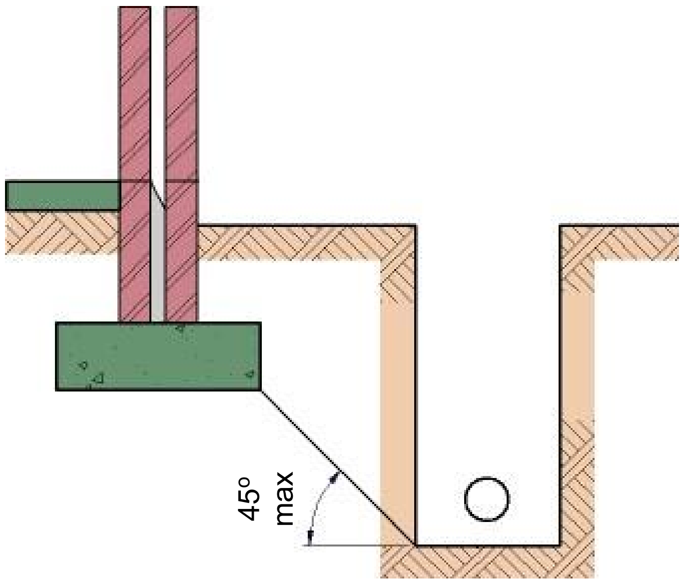
There are aspects of conventional construction where good building practice will improve durability and serviceability, and some of the more important ones are given below.

Foundations

Stiff J S (ed), *Guidelines for urban engineering geological investigations*. South African Institute of Engineering Geologists

A competent person must classify the building site in accordance with the site class designation set out in Table 3 of the SAIEG publication *Guidelines for urban engineering geological investigations* or the SAICE/IStructE code of practice *Foundations and superstructures for single storey residential buildings of masonry construction*.

Drainage trenches must be positioned and excavated in such a manner that they do not pose a risk to the stability of the foundations. Where services will be deep, the angle from the base of the service trench to the base of the foundations normally must not be more than 45°.



Position of drainage trench near foundation

Where foundation trenches have been left open for some time, it is essential to ensure that the bottom of the trench is clear of rubbish or soil which has fallen into the trench. Where the bottom has become too dry and friable or has softened due to rain or ground water, the excavation must be re-bottomed before concreting.

The soil around the building must be shaped to fall at least 75 mm over the first 1,5 metre away from the external perimeter of the building, to ensure that water will not pond against the external perimeter of the building or underscour the foundation. Perimeter slabs around the building must have the same fall.

Concrete, mortar and plaster

Although this is not generally appreciated, concrete, mortar and plaster are very complex products which can easily fall short of requirements, with costly and sometimes disastrous results. It cannot be too strongly recommended that the mix design of concrete, mortar and plaster for every site should be entrusted to a competent person.

Every mix design should furthermore be reviewed by a competent person whenever the source of stone or sand is changed.

Concrete, mortar and plaster mixes are, however, commonly designed and produced on site. As an aid to producing good quality, the following guidance is given.

To achieve an acceptable product it is essential that the materials – stone, sand, cement, lime and water – are suitable for their purpose, are obtained from a consistent source of supply and are properly stored on site to prevent contamination. It is also essential that the batching and mixing of the materials are done by adequately trained people.

Gravel or crushed stone for the coarse aggregate is generally the least troublesome of the materials, but it must be stored and drawn on in such a way that contaminants like soil are not mixed in during the batching process.

Sand should be clean and well graded. Supplies of sand must be checked to ensure that:

- **they contain little or no organic material**
- **they have a maximum grain size not exceeding 5 mm**
- **they have a clay content such that a "worm" 3 mm in diameter cannot be rolled in the palm of the hand by adding a few drops of water to material obtained by sieving a sample of dry sand through a nylon stocking or equivalent fabric**
- **for concrete, when 1 litre of cement is mixed in a container with 3 litres of sand and 3 litres of stone, the mixture does not require more than 750 ml of water to be added to reach a "just right" consistency. (This mix should be set aside in its container in the shade for about 10 minutes. If a layer of water more than 1 mm deep forms on the surface, the sand probably lacks fine material and should be blended with a plaster sand.)**
- **for mortar and plaster, the sand should contain sufficient fines to produce a "fatty" workable mix, but should not contain excessive fines which will result in unacceptable shrinkage and surface cracking or crazing.**

SABS ENV 197-1: 1992, *Cement - composition, specifications and conformity criteria Part 1: common cements*

SABS ENV 413-1: 1994, *Masonry cement Part 1: specification*

SABS 523: 1999, *Limes for use in building*

The cement to be used for mortar must be either ordinary Portland cement (OPC) complying with SABS ENV 197-1: CEM I 32,5 or 42,5, or Portland slag cement complying with SABS ENV 197-1: CEM II/ A-L, S, V, W 32,5 or CEM II/ B-S 42,5.

For mortars and plasters, masonry cement complying with SABS ENV 413-1: MC 12,5 may be used, but this product must not be used in concrete.

For concrete the cement must comply with SABS ENV 197-1.

If other cements are used, a competent person must design every concrete and mortar mix.

Where lime is to be mixed separately with cement for use in mortar and plaster, it must be a hydrated lime complying with SABS 523, Class A3P.

On no account must gypsum plaster be used in the same mix with Portland cement.

No corrosive admixtures, such as calcium chloride, may be added to concrete. Any admixtures must be used strictly in accordance with the manufacturer's instructions.

Water used for concrete, mortar and plaster must be clean and free of foreign and other deleterious matter such as clay. Potable water is acceptable.

It is common practice to batch the ingredients for concrete, mortar and plaster using buckets or wheelbarrows, but the use of such containers is not to be encouraged because of the variability in size and the big difference in volume between a level wheelbarrow and a heaped one. The use of well constructed batching boxes of known capacity, with handles on each side for easy lifting, should be encouraged. Adding the water from a hose should be discouraged because of the lack of control over the quantity added.

Mixing of the materials should preferably be done in a clean, efficient mechanical mixer, with a mixing time of not less than 1½ minutes. Mixing by hand should be done on an impervious, sufficiently large surface. Sand and cement (and/or lime in the case of mortar and plaster) should be dry-mixed first by turning the materials over until an even colour is achieved. Coarse aggregate (for concrete) and water may then be added and the materials turned over again until an even mix is achieved of the required consistency.

Transporting, placing, compacting and finishing of normal site concrete, used under normal environmental conditions, must be done within 2 to 3 hours from the time of batching, with care being taken to avoid segregation or excessive bleeding of free water.

In the case of ready-mixed concrete, the recommendations of the supplier must be followed strictly. Generally, ready-mixed concrete may be placed directly from the rotating drum, provided care is taken that segregation is avoided and the required workability is maintained while ensuring the correct

water:cement ratio at the time of placing (i.e. provided it has the required slump at the time of discharge - without the addition of extra water).

For the use of special concrete and for concrete to be used under abnormal conditions, advice from a competent person must be sought.

The addition of water to concrete, mortar or plaster (retempering) which has stiffened, ie taken its initial set, must not be allowed.

Concrete must be wet-cured for at least 7 days, and plaster must be moistened and protected from direct sunlight or strong winds for at least 3 days to reduce drying shrinkage and crazing.

Gypsum plaster and gypsum-based fillers must not be used externally, in bathrooms, kitchens or other wet or damp areas.

Addis, B J *Cement concrete and mortar*. Cement and Concrete Institute, Midrand, Gauteng, South Africa

Patching and repair of damaged or defective concrete should be done in accordance with the recommendations contained in the Cement and Concrete Institute's booklet *Cement, concrete and mortar*.

Polymer-based admixtures are available which can improve the strength, resilience and bonding of patching concrete. These admixtures must be used in strict accordance with the manufacturer's instructions.

Steel fittings and fixtures

SABS ISO 1461: 2000, *Hot dip galvanized coatings on fabricated iron and steel articles - specifications and test methods*

In coastal areas and areas subject to industrial pollution all external steel components, such as door frames, window frames, roof sheets, flashings, etc., must be hot-dip galvanised in accordance with SABS ISO 1461 – in particular the minimum mean thickness of the zinc coating must be 45 µm. It must receive the additional protection of a suitable paint coating system.

The end and side laps of galvanised steel roof sheets must be pre-coated and the whole exposed roof painted as soon as practical after completion.

In coastal areas mild steel roof ties must be hot-dip galvanised also. If they are completely covered by the roofing and a closed eaves they may be left unpainted. If roof ties are exposed, as for example on open verandahs or balconies, they must be of stainless steel.

Timber

SABS 1783-2: 1999, *Sawn softwood timber Part 2: Stress graded structural timber and timber for frame wall construction*

Timber for roof trusses, purlins, tiling battens and ceiling brandering must be structurally graded and stamped (in red) with the appropriate SABS grade mark. If the timber is marked with a black cross it is ungraded and must be rejected.

Republic of South Africa. National Building Regulations. Government Notice No R. 2378, Government Gazette No 12780, Pretoria, South Africa, 12 October 1990

BOU/E9703: 1997, *Introductory guide to painting*

SABS 0112: 1971, The installation of polyethylene and unplasticized polyvinyl chloride pipes

SABS 533-1: 1982, *Black polyethylene pipes for the conveyance of liquids Part 1: Low density black polyethylene pressure pipes*

SABS 533-2: 1982, *Black polyethylene pipes for the conveyance of liquids Part 2: High density black polyethylene pressure pipes*

SABS 533-3: 1995, *Black polyethylene pipes for the conveyance of liquids Part 3: High-density black polyethylene PE 80 pressure pipes*

SABS 966-1: 2000, *Components of pressure pipe systems Part 1: Unplasticized poly(vinyl chloride) (PVC-U) pressure pipe systems*

SABS 966-2: 2000, *Components of pressure pipe systems Part 2: Modified poly(vinyl chloride) (PVC-M) pressure pipe systems*

The National Building Regulations prescribe that all timber must be treated against termite and wood borer attack and fungal decay.

An approved preservative must be used.

Paint

It is recommended that paints be selected from reputable manufacturers and that the advice of their technical staff be sought if there is any doubt about the correct paint system to be used in any situation. *The introductory guide to painting* produced by CSIR Building and Construction Technology gives useful recommendations on the selection of the correct paint systems.

Water supply piping

The most commonly used materials for water piping in buildings are still galvanised steel and copper. Plastic piping is mainly used because of its resistance to corrosion and its lower cost.

Galvanised steel is vulnerable to corrosion from chlorides and sulphates, either in the water or in the soil, and is not recommended for use where aggressive soils are present or where exposed piping may be attacked by sea spray or excessive industrial pollution.

Using different metals in one installation may lead to corrosion due to galvanic action and should be avoided if possible. If galvanised steel and copper pipes are used in the same installation, the copper pipe should always be put downstream of the galvanised steel.

Copper piping is much less vulnerable to corrosion and is recommended for use in aggressive soils, coastal areas and heavily polluted industrial areas.

Plastic piping is accepted by most municipalities, in terms of the Joint Acceptance Scheme for Water-Services Installation Components (JASWIC). Due to the high thermal expansion of plastics great care should be taken to accommodate thermal movement as prescribed by the manufacturers of these pipes. Adequate support and anchoring for the piping systems and outlets must be provided. Provision for periodic inspection and maintenance must also be provided.

There are SABS standards covering high density polyethylene, polyvinyl chloride (PVCm and PVCu) and polypropylene piping, and a code of practice for the installation of polyethylene and unplasticised polyvinyl chloride piping (**SABS 0112**-1971). It is recommended that connections should be made with acceptable compression joint fittings rather than by heat fusion.

It is common practice to run water piping in buildings under surface beds, in concrete slabs or in chases in the brick walls which are subsequently plastered up. In the event of a pipe failure or leakage at a joint the inconvenience and cost of locating and repairing the fault can be considerable. It is strongly recommended that, as far as possible, the system should be pressure tested before final finishes are applied. The positioning of pipes in ducts to which access can be gained subsequently for the repair or replacement of the pipes is desirable.

Earthing of roof sheeting

All metal roofs of premises that are supplied with electricity must be earthed, except where electricity is supplied by underground service connection.

Such earthing must be carried out at points not more than 6 m apart (measured along the roof perimeter at eaves level).

SABS 0313: 1999, *The protection of structures against lightning*

Where roofs are not required to be earthed as defined above, it is nevertheless recommended that in the case of dwellings, the metal roof be earthed in accordance with the requirements of **SABS 0313**.

In order to minimise corrosion, earthing of steel roofs is best achieved by bolting flat aluminium or copper conductors to the underside of eaves. Sheet coatings must be removed down to base galvanising at the conductor/sheet interface and connections should be completely sealed to prevent the entry of moisture.

RAINWATER PENETRATION AND DAMP-PROOFING

A properly designed and constructed building should not leak! In spite of this, rain too often penetrates into new buildings through the roof, the external walls and the windows; and ground water too often rises into the building through the walls and floors, due to poor design or poor construction.

SABS 021:1998, *The waterproofing of buildings (including damp-proofing and vapour barrier installation)*

Flat roofs and roofs with low-pitched metal sheeting are most at risk. SABS 021 deals with these to some extent, but designers and builders must make use of the technical data sheets prepared by the manufacturers of the newer forms of waterproofing membranes and of long-span metal sheeting and must follow carefully the instructions contained in them, with particular reference to minimum slopes, side and end overlaps, fixing methods and flashing.

It is strongly recommended that roofs with low-pitched metal sheeting should have a minimum slope of 3°.

Designers of tiled roofs must also stay within the minimum roof slopes recommended by the tile manufacturers for each product. Where the tile manufacturer recommends the use of an underlay, an SABS or Agrément approved membrane must be used in accordance with the manufacturers' directions.

Cracking of solid external walls will allow rainwater to penetrate into the building, so every effort must be made to minimize cracking. The supporting soil must be stable and properly compacted, the brick or block building units must be correctly bedded and all joints, especially the vertical joints, properly filled and tooled.

Clay Brick Association, Halfway House, South Africa: 1997, Design, detailing and specification technical guide series. *Clay brickwork: design, detailing and good building practice*

CSIR Building and Construction Technology: BOU/E9602:1996, *Water penetration in face brick walls*

Lane J W, Kelly P J, Catsavis J H:1993, *Guidelines on the detailing of concrete masonry. Volume 1. Solid units*

Lane J W, Kelly P J, Catsavis J H:1993, *Guidelines on the detailing of concrete masonry. Volume 2. Hollow units*

Lane J W, Kelly P J, Catsavis J H:1993, *Guidelines on the detailing of concrete masonry. Volume 3. Cavity walls*

Useful advice on wall construction and control joints is given in the technical guides available from the Clay Brick Association and the Concrete Masonry Association.

Solid facebrick walls are acceptable in inland areas, but do not perform well in the coastal areas. In the latter areas rain penetration can be controlled by external plaster and a good paint system or by the use of well-constructed cavity walls with clean cavities. Further useful advice may be found in the CSIR Building and Construction Technology publication *Water penetration in face brick walls*.

Selection and installation of windows is also important. Design must be suitable for the weather to which the window will be exposed and installation must be secure and must incorporate the horizontal and vertical (in cavity walls) damp-proof courses necessary to keep the rain out. The fixing holes in steel windows should be sealed. In exposed areas it is desirable to apply a bead of sealant around the perimeter of the frame to seal the cracks which usually form at the junction between the frame and the surrounding masonry or plaster.

SABS 0400: 1990, *The application of the National Building Regulations*

SABS 0400 requires that the damp-proof courses (DPCs) shall be set not less than 150 mm above the adjacent finished ground level. It is false economy to save on foundation brickwork or blockwork by ignoring this requirement. It is common practice in South Africa to lay the DPC directly onto the bricks, blocks or concrete floor slab, but this method of installation produces the risk of puncture damage from the underlying materials and of water penetrating from below the DPC into the inside.

Once the ground floor slab of a building has been cast, moisture accumulates under the slab because the ground there is cooler than the surrounding soil and because evaporation of the water at the surface has been blocked. Formerly it was normal practice to provide a layer of hardcore below the slab to prevent the soil moisture rising by capillary action, but it is now normal practice to cast the slab onto a compacted layer of soil or sand.

SABS 952: 1985, *Polyolefin film for damp- and waterproofing in buildings*

It is therefore essential to block rising damp by covering the backfill with a continuous damp-proof membrane, such as plastic sheeting complying with SABS 952 or approved by Agrément South Africa. Sheet overlaps must be at least 100 mm and must be sealed. The membrane must be taken up and over all foundation walls to overlap with the DPC in the walls.

CSIR Building and Construction Technology, BOU/E9604:1996, *Rising damp*

Further guidance on the damp-proofing of buildings can be obtained from the CSIR Building and Construction Technology publication *Rising damp.*