DESIGN DOCUMENTATION REFERENCE GUIDE

Certification of Soils and Design Report - Obligations of Builder and Home Owner/Occupier

The performance of the footings and slab or both is largely depended upon a responsible approach by the builder and owner/occupier towards vegetation and site drainage.

THE DESIGN DOCUMENTATION REFERENCE GUIDE VERSION 6002:2.1

1. Is part of this Foundation Design Report and this Foundation Design Report cannot be relied on without it;
2. Must be read and understood by the builder;
3. Contains mandatory requirements, and all mandatory requirements must be complied with by the builder;
4. Contains recommendations, and all recommendations should be complied with by the builder.

THE HOME OWNER'S REFERENCE GUIDE VERSION 6002:1.1.

1. Is part of this Foundation Design Report for the use of the homeowner/occupier;
2. Must be read and understood where appropriate by the homeowner/occupier;
3. Contains mandatory requirements, and all mandatory requirements must be complied with by the homeowner/occupier;
4. Contains recommendations, and all recommendations should be complied with by the homeowner/occupier.

Where there is ANY FAILURE of the builder or homeowner/occupier to comply with the above obligations then the RESPONSIBILITY for ANY FAILURE rests with the builder or homeowner/occupier.

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SECTION 1. INTRODUCTION

1.01 GLOSSARY OF TERMS

The following are definitions of words used in this report and attached documents.

"Allowable Bearing Capacity" – Maximum bearing pressure that can be sustained by the foundation from the proposed footing system under service loads which should avoid failure or excessive settlement.

"Articulated full masonry" – full masonry construction in which special provision is made for movement by articulation.

"Articulated masonry veneer" – masonry veneer construction in which the provisions for articulated masonry have been applied to the masonry veneer.

"Bored pier" – in-situ concrete cylindrical load support element.

"Bulk pier" – in-situ concrete load support element excavated by backhoe or similar.

"Clad frame"- timber or metal frame construction with the exterior wall clad with timber or sheet material not sensitive to minor movements. Includes substructure masonry walls up to 1.5m high.

"Clay" – fine grained soil with plastic properties when wet. Includes sandy or silty clays.

"Continuous footing" – footing of rectangular section.

"Controlled fill" – material that has been placed and compacted in layers by compaction equipment within a defined moisture range to a defined density requirement in accordance with Clause 6.4.2(a) and AS 3798.

"Dynamic Cone Penetrometer (D.C.P)" – field equipment used to determine underlying soil strength by measuring the penetration of the device into the soil after each hammer blow.

"Edge beam" – beam at the edge of a slab-on ground or stiffened raft.

"Edge footing" – footing at the edge of a footing slab.

"Foundation" – ground which supports the building.

"Footing"- construction which transfers the load from the building to the foundation.

"Footing system" – general term used to refer to slabs, footings, piers and pile systems used to transfer load from the structure to the foundations.

"Full masonry" –construction with masonry double-leaf external walls and masonry single-leaf internal walls without full articulation.

"House" – detached single dwelling constructed as Class 1 , or Class 10a as defined in the Building Code of Australia, with limitations as stated in this standard.

"Liquid limit (wl)" – moisture content at which the soil passes from plastic to the liquid state as determined by the liquid limit test.

"Linear Shrinkage (LS)" – decrease in length expressed as a percentage of the original length when a sample of soil is oven dried from a moisture content of about the liquid limit as determined by the linear shrinkage test.

"Load- bearing wall"- any wall imposing on the footing a service load greater than 10 kN/m.

"Masonry" – stone, brick, terracotta block, concrete block, or other similar building unit single or in combination assembled together unit by unit.

"Masonry veneer" – house construction consisting of a load-bearing frame clad with an outer leaf of masonry.

"Pad footing"- concrete footing used to support a pier or stump.

"Pier and Beam" – footing system incorporating bored piers, bulk piers or piles supporting a suspended slab and including a slab partly supported on piers and partly supported on ground.

"Plastic limit (wp)" – moisture content at which the soil becomes too dry to be in a plastic condition as determined by the plastic limit test.

"Plasticity index (Ip)" – numerical difference between the liquid limit and the plastic limit of a soil.

"Pocket penetrometer (PP)" – instrument used to evaluate consistency and approximate unconfined compressive strength of saturated cohesive soils.

"Rock" – strong material including shaley material and strongly cemented sand or gravel that does not soften in water. Material that cannot readily be excavated by a backhoe may be taken to be rock.

"Reactive site" – site consisting of a clay soil which swells on wetting and shrinks on drying by an amount that can damage buildings on light strip footings or unstiffened slabs. Includes sites classified as S, M, H, or E in accordance with Clause 2.1.

"Sand" – granular soil that may contain a small proportion of fines including silt or clay. The amount of fines may be assessed as small by visual inspection or if the amount passing a 425 um sieve is 15% or less. Material with a higher proportion of fines shall be treated as silt or clay.

"Services" – means all under ground services to the site including but not limited to power, telephone, sewerage, water & storm water.

"Site" – (insert the address and/or lot description)

"Slit"- fine grained soil that is non-cohesive and non plastic when wet, can include some sand and clay.

"Slab-on-ground" – concrete floor supported on the ground and incorporating integral edge beams.

"Surface movement (Ys)" – design movement at the surface of a reactive site caused by moisture changes.

"Standard residential allotment" – means that if the lot/allotment is larger than 650 metres square then the client needs to identify where the proposed dwelling structure is to be erected.

"Stiffened raft" – concrete slab on ground stiffened by integral beams and a grid of internal beams.

"Stump" – element supported on a footing used for the support of a frame construction.

"Waffle raft" – a stiffened raft with closely spaced ribs constructed on the ground and with slab panels suspended between ribs.

1.02 DISCLAIMER

ALL REPORTS ISSUED BY SOILTEST AUSTRALIA ENGINEERING SERVICES PTY LTD, HAVE THE FOLLOWING LIMITATIONS.

Where any footing excavations may indicate significant variations to the ground conditions specified in this report then Soiltest Australia Engineering Services Pty Ltd must be informed immediately before further work proceeds on site.

The site classification is based on the condition of the site at the time of the investigation and does not take into account any proposed earthworks or proposed site preparation details unless those details were provided in writing at the time of our engagement. If any extensive cutting, cut/filling or total filling is proposed, a reassessment of the site classification will be required.

The information contained within this report is only applicable to the site address supplied by our client. Also, if the site is not a standard residential allotment, information contained in this report is only relevant to those areas investigated.

The bore hole locations, slope directions, north point and offsets are estimations only and should not be taken as being accurate or relied on for set out.

It is the client's sole responsibility to determine:-

- the set out of any proposed dwelling on the site;
- the location of any services.

This report does not cover slope stability. If this is required, it is recommended that an independent test be carried out by a qualified Geotechnical Engineer specialising in this area.

This report does not cover termite prevention, investigation or treatment. Any queries concerning these matters should be referred to an appropriately qualified person.

It s the client's obligation to advise Soiltest Australia Engineering Services Pty Ltd in writing of any known or suspected peculiarities or irregularities concerning the site.

Where Soiltest Australia Engineering Services Pty Ltd relies upon information and documentation provided by the client the responsibility for the accuracy of any such information or documentation so provided is the client's sole responsibility.

Where the site is situated in a new development, it is the responsibility of the client to provide certifications of fill compaction to Soiltest Australia Engineering Services Pty Ltd at the time of our engagement to prepare this report. Where the relevant certifications of fill compaction are not provided by the client to Soiltest Australia Engineering Services Pty Ltd then the classification of this site may change which may increase the over all costs of construction of the proposed dwelling on the site. Where the certifications of fill are provided after the completion of this report, then the client will be liable for an additional fee for the work necessary to revise the report in view of that additional documentation.

This report should only be relied upon by the client where the report is provided in an original format and not as a copy.

Disclaimer

This report is for the addressee only and Soiltest Australia Engineering Services Pty Ltd specifically disclaims liability to any other party. Nothing in this report may be extracted or reprinted without the prior written consent of Soiltest Australia Engineering Services Pty Ltd.

ALL CERTIFICATES AND APPROVALS ISSUED BY SOILTEST AUSTRALIA ENGINEERING SERVICES PTY LTD, HAVE THE FOLLOWING LIMITATIONS

Any certification does not relieve the builder of his/her/its responsibility to ensure the work is carried out with reasonable care, skill and diligence required of a registered builder.

A visual inspection only of the works has been carried out.

Materials have not been tested to establish compliance with relevant standards or specifications.

Any certification may only be relied upon by the addressee and no other person.

The checking of set out is NOT the responsibility of Soiltest Australia Engineering Services Pty Ltd and any certification by us does NOT cover any such aspects of construction.

It is the SOLE responsibility of the builder that any and all items on the inspection check list are completed before proceeding.

1.03 QBSA SUBSIDENCE - LEGISLATIVE REQUIREMENTS

The Policy that everyone plays a part

In April 2003 the Queensland Building Services Board instigated a review of the causes of footing and slab movement. The review focused on design and construction of footings and slabs including legislation and standards as well as skill levels and education of practitioners. It also considered the escalating costs to BSA's statutory fund.

Preliminary findings of a research project commenced in May 2003 identified two areas that required special attention. They were: Engineering Investigation and Design and Construction Practices.

After informing industry of the review in September 2003, the Queensland Building Services Board recently endorsed a new Policy for Rectification of Building Work in residential construction. This includes work that causes footing slab movement.

A Fact Book, distributed throughout Queensland, is aimed at ensuring that all participants in the building industry are properly informed about, and understand how to comply with, the no fault provisions of the new policy. Similarly, a further BSA education initiative will endeavour to ensure home owners are made more aware of their responsibilities for the ongoing maintenance of their homes.

Please read your requirements and make use of the resources from BSA's website, ensure you fully comprehend the requirements of the relevant sections of the Building Code of Australia and have an understanding of Australian Standard 2870.

Your understanding and compliance with these requirements and your assistance in ensuring home owners are aware of their own maintenance responsibilities will help minimise the incidence of footing and slab movement. This in turn will reduce your costs for rectification, and ultimately, the burden that industry bears due to problems created by defective work.

QBSA Subsidence Policy.

RESPONSIBILITIES – *Everyone has their own.*

Previous Policy

To avoid responsibility for rectification of subsidence under the previous policy, the contractor only had to rely on information provided by an engineer, follow the requirements of the engineer as specified and have the work certified by a competent person.

This is NOT the case now.

Where contracts or preliminary agreements are entered into after 1 September 2004, the contractor must ensure that the contractor is provided with all the information relevant to the construction. The contractor must also ensure that the engineer provides a design and certifies that it complies with the information the contractor has provided and the requirements of the relevant codes and standards.

Both the performance of footing and slab systems and the continued serviceability of buildings rely on the contractor and the homeowner complying with construction practices and site maintenance conditions. The Australian Standard relies on normal conditions being maintained throughout the life of buildings.

Both the contractor and the home owner have a duty to know their individual responsibilities.

The Contractors Responsibility.

It is the responsibility of the contractor to ensure that relative performance in residential construction is achieved by compliance with three strategic areas.

The first of these strategic areas relates to site investigation.

Under this section the contractor must provide the engineer/ site classifier with all relevant information and conditions to enable site identification and investigation to be completed.

- The information the contractor must give to the engineer/site classifier is:
- Property description and site address.
- Evidence to ensure site is correct. i.e. Survey plan and or photograph to assist in correctly identifying the site.
- The contours of the site.
- The location of trees on the site and adjoining sites.
- Location and identification of existing overland flows.
- The footprint of the proposed building and an indication of platform levels.
- Location of proposed cut and fill line.
- Land searches including potential flooding, any underground infrastructure, easements, vegetation and subdivisional fill.

NOTE: For the purpose of the policy the contractor is to ensure that all care is taken to identify any existing impediments that may influence the site classification and the design at the time of the investigation (where possible), e.g. identifying and plotting trees currently existing including any known recently removed trees.

INFORMATION – *Everyone needs to know*.

This information, noted on the site plan, will assist the engineer to correctly locate test sites over the area of the building platform and to consider the effects of cut and fill operations and any other influences that may affect the proposed structure.

It will also assist in alleviating a key factor in footing failures – that of the design engineer and/or site classifier not taking into account all of the conditions of the site and adjacent sites.
The information provided to the engineer will also assist the contractor in determining the extent of work required under the contract and who is responsible for that work. For example, the contractor can incorporate into the contract, who is responsible for building and paying for any retaining walls, paths or spoon drains that may be required for site drainage.

This should prevent any contractual arguments.

Other notes relating to builders responsibility that may be helpful include:

a) The contractor may require that the Site classifier and/or the designer obtain certain information noted on page 3 but not supplied by the contractor. In such instances, the site classifier and/or the designer must satisfy themselves that they have obtained all the relevant information necessary to complete the design and meet the requirements of the Queensland Building Services Board Policy. The relevant information should be noted in the engineer design certification.
b) Where the owner has engaged the site classifier and/or engineer, the contractor must ensure that the engineer certifies that the information was obtained and taken into account for the purpose of the site classification and/or design, in accordance with requirements of the Queensland Building Services Board Policy.

THE SECOND STRATEGIC AREA OF CONTRACTOR RESPONSIBILITY UNDER THE NEW POLICY IS SITE CLASSIFICATION AND DESIGN.

Under this section the contractor must obtain written confirmation from a Registered Professional Engineer in Queensland (RPEQ), that the policy requirements have been met in identifying and classifying the site and in completing the engineers design.

For ***Site Classification***, the contractor must obtain from the engineer **written** confirmation that:

- The engineer or their representative has visited the site.
- The soil testing has been undertaken by a Registered Professional Engineer in Queensland or a soil tester licensed under the Queensland Building Services Authority Act 1991.
- The minimum of two (2) boreholes have been located over the proposed footprint of the building and below the final platform level.
- Soil samples have been taken for the purpose of laboratory testing where required.
- A laboratory test and a soil report have been obtained for the design engineer.

For the ***Engineer Design***, the contractor must obtain confirmation that:

- The design engineer has referenced and taken into account all the relevant information supplied.
- The design has been certified by a Registered Professional Engineer in Queensland.
- The design drawings include and detail all the requirements outlined in paragraph B(b) (x) of the policy.
    - selected footing system,
    - specific site works,
    - site drainage,
    - control joints,
    - retaining wall,
    - flexible joints in storm water and sanitary drainage.

DESIGN – *Everyone needs to take care.*

Where an alternate footing system to that described in Part 3.2 of the BCA is proposed, it must comply with Performance Requirement 2.1 and Performance Requirement P2.2.3 in section 2 of the BCA.

Where alternate footing systems other than those recognised by AS 2870 and described in the BCA are proposed, ***the contractor should obtain from the engineer,*** written confirmation of the validity of the design using engineering principles conforming to and deemed to satisfy requirements of the BCA and relevant Australian Standards.

It is noted in AS 2870 that the expectation and parameters of the design of all footing and slab systems including alternate footing systems using engineering principles should take into consideration that, “foundation movement shall be assessed as the level which has less than a 5% chance of being exceeded in the life of the structure which may be taken as 50 years.” Clause 1.4.2 AS 2870 1996

Where ***abnormal conditions*** exist on a site it is usual that an engineer classify the site as “P” and indicate the expected movement potential depending on the reactive soil characteristics. i.e. A,S,M,H, & E. Classifications.

Design of the footing systems on “P” sites shall use conforming engineering principles detailed in AS 2870 and the Australian Standard for Concrete Structures – AS3600.

Abnormal site conditions should be identified as part of site identification and investigation and may include:

- soft soil – such as uncontrolled fill or development fill sites including soft clay or silt or loose sand. (bearing capacity less than 100 kpa);
- landslip
- mine subsidence and collapsing soils
- soils subject to erosion
- reactive sites subject to abnormal moisture conditions
- sites that cannot be classified otherwise

Abnormal moisture conditions that affect the site classification for the design assessment may include:

- Recent removal of an existing building structure
- Unusual moisture conditions caused by drains, channels, ponds, dams or tanks which are to be maintained or removed from the site. Canal developments that have deep seated clays are an example where abnormal moisture conditions may prevail over time.
- Removal of large trees prior to construction
- Trees located too close to a footing (including trees on an adjoining site within the relevant distance of the mature height of the tree from the building depending on site classification).

Information on drawings for reactive sites shall include site classification, selected footing system and any special sitework or site drainage. (Clause 1.10 AS 2870 1996)

Additional requirements for H & E site classifications pursuant to AS 2870 1996, clause 5.5 – Additional Requirements for class H & E Sites, shall be included.

NOTE: Examples of information that should typically be specified is shown in the diagram on page 7 of this document.

CERTIFICATION – *Everything must be right*.

THE THIRD STRATEGIC AREA OF CONTRACTOR RESPONSIBILITY UNDER THE POLICY IS COMPLIANCE WITH THE DESIGN.

Under this section the contractor must comply with the design and the relevant Australian Standard both during and on completion of construction.
To comply with the design and relevant Standards, the contractor must obtain the following certification:

- Certified design drawings and specification to be obtained from RPEQ prior to commencing siteworks and construction.
- Certification from RPEQ or Building Certifier that the building platform, site drainage and any other special siteworks comply with the certified design.
- Certification by RPEQ or Soil Tester licensed under the QBSA Act 1991 of compaction tests carried out on controlled fill. Note: Certification to be compliant with relevant standard i.e. AS3798 or AS1289.
- Certification by RPEQ or Building Certifier that footing and slab systems comply with the certified design and relevant Australian Standards. Certification must include confirmation that the original site classification has not altered. Any altered site conditions or construction requirements not in the certified design ***must comply*** with any instruction from the RPEQ or building certifier.
- Certification by RPEQ, Building Certifier and/or approval by the local government plumbing inspector that installed plumbing, drainage and stormwater flexibility for the relevant site classification is in accordance with certified design requirements and relevant Australian Standard.
- Certification by RPEQ or Building Certifier that masonry articulation, site drainage requirements, roof storm water, location of retaining walls and any other special site works have been completed as specified.

Builders are reminded that they have a duty of care to be aware of all aspects of the ***Building Code of Australia 1996 (BCA) Volume 2 Parts 3.1 & 3.2,*** which clearly set out the acceptable construction practices in relation to construction requirements for Site Preparation and Footings & Slabs for residential construction.

ADDITIONAL INFORMATION
The new subsidence policy document, an “Owner Information And Responsibility Form” and Guidelines for :

- Site Classifiers
- Design Engineers and
- Responsible Certifiers can be obtained from the “TechInfo” section of BSA’s website at www.bsa.qld.gov.au

Commission of Report

Soiltest Australia Engineering Services Pty Ltd has been commissioned to undertake a foundation design report. In preparing this report we have been provided by you or your agent the following details. These details have been relied upon in the preparation of the design document:-

NOTE: Under QBSA subsidence policy the required information that is to be supplied to the engineer prior to site investigation.

- Property description and site address
- Evidence to ensure site is correct
- The contours of the site
- The location of trees on the site and adjoining site
- Location and identification of existing overland flows
- The footprint of the proposed building
- Location of proposed cut and fill line and/or an indication of platform levels
- Land searches for any underground infrastructure
- Mining search (if applicable)

NOTE: Under QBSA subsidence policy we the engineers confirm the following "Site Classification"

YES The engineer or their representative has visited the site
YES The soil testing has been undertaken by a Registered Professional Engineer in Queensland
YES The minimum of two (2) bore holes have been located over the proposed footprint of the building and below the final platform level.
YES Soil samples have been taken for the purpose of laboratory testing where required
YES A laboratory test and a soil report have been obtained for the design engineer

NOTE: Under QBSA subsidence policy we the engineers confirm the following "Engineers Design"

YES The design engineer has referenced and taken into account all relevant information supplied
YES The design has been certified by a Registered Professional Engineer of Queensland.
YES The design drawings include and detail all the requirements outlined in paragraph B(b)(x) of the new policy.

Soiltest Australia Engineering Services Pty Ltd confirms from an engineering perspective, compliance with the engineer's obligations in the QBSA Subsidence Policy for the below mentioned items, subject only to:-

1. The below mentioned items were assessed at the time of the site investigation.
2. The builder, in accordance with the QBSA Subsidence Policy has met all the requirements and supplied all relevant searches.

1.04 COMMISSION OF REPORT

NOTE: under QBSA subsidence policy we the engineers confirm the following "Abnormal Site Conditions"

- Soft soil – such as uncontrolled fill or development fill sites including soft clay or silt or loose sand. (Bearing capacity less than 100 kpa);
- Landslip;
- Mine subsidence and collapsing soils;
- Soils subject to erosion;
- Reactive sites subject to abnormal moisture conditions;
- Sites that cannot be classified otherwise.

NOTE: Under QBSA subsidence policy we the engineers confirm the following checklist for "Abnormal Moisture Conditions".

- Recent removal of an existing building structure
- Unusual moisture conditions caused by drains, channels, ponds, dams or tanks which are to be maintained or removed from the site. Canal developments that have deep seated clays are an example where abnormal moisture conditions may prevail over time.
- Removal of large trees prior to construction.
- Trees located too close to footings (including trees on adjoining sites within the relevant distance of the mature height of the tree from the building depending on site classification).

This report is provided pursuant to the Professional Engineers Act (QLD) 2002. This soil test and foundation report has been prepared by reference to;

Site Classification Criteria
AS 1289 – 1991 Methods of testing soils for engineering purposes
AS1726 – 1993 Site Investigation Code
AS 2870 – 1996 Classification of site in accordance with "Residential Slab & Footings"
AS 3798 – 1996 Guidelines on earthworks for commercial and residential development.

Design Criteria
BCA "The building code of Australia"
AS 1170.2 – 2002 SAA loading Code
AS3600 – 1994 Concrete Structures
SAA HB28 – 1997 The design of residential slabs and footings.

Soiltest Australia Engineering Services Pty Ltd, reserves the right under it's "Duty of Care" to change any recommendations within the structural documentation as a result of decisions taken by the designing engineers using their prerogative and duty of care responsibilities.

To ensure correct footing and/or slab construction it is essential that a copy of this report and any relevant addendum's (where applicable) are supplied to the concreter prior to the commencement of any works. It is also advisable that this report is available on-site for reference by the concreters and nominated inspectors.

Site maintenance is the responsibility of the home owner to ensure long term stability of the proposed structure. It is a requirement that the recommendations pertaining to trees, root barriers and general site maintenance outlined in the appendix attached are adhered to for the life of the structure. This information must be forwarded on where the property is to change ownership.

SECTION 2. SOILTEST & REPORT PARAMETERS

2.01 SITE CLASS AND POTENTIAL SURFACE MOVEMENT

Methods adopted are in accordance with guidelines specified in AS 2870 – 1996, appendix D. Potential surface movement and the resultant site classification are therefore consideration of the local depth of the zone of consideration of significant soil moisture variations and the entire ground profile. This includes the influence of "reactive" clay based soils and/or the presence of fill, as well as the effect of "stable" materials such as dense sands or shallow rock. Site classification is divided into various classes, dependent upon the "Ys" (potential movement). Classifications are;

Site Classification Symbols	Description
....."*A".....	Most shallow rock sites and some sand sites with little potential for movement through moisture change.
....."*S".....	Slightly reactive sites, have only slight potential for ground movement through moisture change.
....."M".....	Moderately reactive sites, can under go moderate ground movement through moisture change, May be considered as your average site.
....."H".....	Highly reactive sites, can experience a high level of ground movement. Additional costs are generally incurred in building on such sites.
....."E".....	Extremely reactive sites can experience extremely high amounts of ground movement. Special considerations should be taken into account when building on these sites
....."P".....	Problem sites which generally have soils associated with uncontrolled fill, mine subsidence, landslip, or soft or collapsing soils.

***A**dditional costs can be incurred on sites due to possible difficulties in excavations/earthworks.*

2.02 FIELD AND LABORATORY PROCEDURES

Site testing is constructed in strict accordance with AS 1726 – 1993, "Geotechnical site investigations". Insitu scala-cone penetrometer and shear vane testing are converted to allowable bearing pressures. Refer respectively to "Determination of Allowable Bearing Pressures Under Small Structures" (1977) by MJ Stockwell and "Skemptons's Theorem" (1954). Clay based soils are sampled and tested for their plasticity parameters, in accordance with AS 1289 3.1.2, 3.4.1 and 6.3.2. Soiltest Australia Engineering Services Pty Ltd is also NATA (National Association Testing Authorities) accredited for appropriate test procedures.

2.03 Y'S METHODOLOGY

Since the advent of Australian Standards A.S. 2870 it has been a requirement to quote a Y's value in the determination of "Site Classifications". Attached are two methods of determination of Y's in accordance with the alternative SITE CLASSIFICATION BY SURFACE MOVEMENT CALCULATION (A.S. 2870.2 -1990) Appendix "D"

Assessment of the Reactive Movement "Ys" Using Shrink/Swell Test Results

The general suction range "Hs" for the Brisbane area is 2 metres in the absence of a water table or rock. For Ipswich take 2.3 metres. For western regions take 3 metres or more. Reactive movement ys is derived from the following relationship:

Ys = (1/100 . Iss). êμ . êdh

Where: ISS = shrink/swell value: êμ = change in soil suction and êdh = change in Hs

This suction change is taken as 1.2 for the Brisbane/Ipswich and Toowoomba areas: there is no published data for the western regions: 1.5 is suggested.

The suction change value for the Brisbane area is 1.2 at ground surface (êdh = zero), expiring to zero at êdh = 2 metres. The boundary of the crack zone is taken at 0.5 Hs or 1 metre in the case of a 2 metre Hs soil profile. That is the êdh value at the junction of the cracked/uncracked zones = 1.0 metre.

Assuming the ISS value of 3.5, within the cracked zone (that is 0 to 1 metre in a 2 metre Hs Brisbane profile) the proportion of the Ys is calculated:

1 Iss value 3.5
2 Centre of cracked zone layer = 0.5 metre
3 Suction change êμ at centre of layer (2000mm – 500 mm) / 2000 = 0.75
4 ys = (1/100 . 3.5) . 1 . 0.75 . 1000mm = 26mm

Assuming the same Iss value of 3.5 within the uncracked zone (that is 1 to 2 metres in a 2 metre Hs Brisbane profile) the proportion of Ys is calculated

5 Iss value 3.5
6 Centre of uncracked zone layer = 1.5 metres
7 Suction change êμ at centre of layer = (2000 mm – 1500 mm) / 2000 = 0.25
8 a = 2 – z/5 where z = 1.50 = 2 – 0.3 = 1.70
9 ys = (1/100 . 3.5) . 1.7 . 0.25 . 1000 mm = 15 mm

Total ys = 26 mm + 15 mm = 41 mm. Reporting to nearest 5 mm , ys = 40 mm.

Note: in the case where controlled fill has been placed less than 5 years prior to building, the depth of the cracked zone should be taken as zero. In such a case ys would be:

10 Iss = 3.5
11 Centre of layer = 1.0 metre
12 Suction change êμ at centre of layer = (2000 mm – 1000 mm) / 2000 = 0.5
13 a = 2 – z/5 = 2 – (1.0/5) = 2 -02 = 1.8
14 ys = (1/ 100 . 3.5) . 1.8 . 0.5 . 2000 = 63 mm. Reporting to nearest 5mm, ys = 65mm.

Assessment of the Reactive Movement "Ys" Using Atterberg Test Results

Y's Rapid Calculation Method:

For any given soil profile, we can calculate a Y's using Ground Movement Chart (Appendix "D" Fig.D1 AS2870.2-1990). The following information is quoted in various sections of AS2870.

1. The Liquid Limit is a pF of 2 and a oven dry pF of 7 which gives a pF is 5 as stated in AS2870.2-1990 Appendix "D" Table D1 the pF for Brisbane of 1.2.

2. The effect of suction (Zone of Influence) as stated in AS2870.2-1990 Appendix "D" as per Table D1 is 2.0 metres for Brisbane.

3. There is a linear reduction in the suction to a depth of 1.5 metres. However if rock is encountered, truncate the profile and the suction effect, as stated in AS2870.2-1990 Appendix "D" Figure D1.

4. For the purpose of calculating Y's the following shall apply:

The Rapid Calculation Method assumes that the interfaces occur at 300mm levels or multiples of 300mm, where the interfaces are not at 300mm levels some interpolation will be required.

***Reference: AS2870-1990 Appendix "D"**

Oven Dry pF 7
Therefore pF of L.S =5
For a pF 1.2 the Layer Movement is 1.2/5 = 0.24 (Linear Factor)

Calculations

M.P. (Movement at pF 1.2) = L.T. (Layer Thickness) x 0.24 x L.S

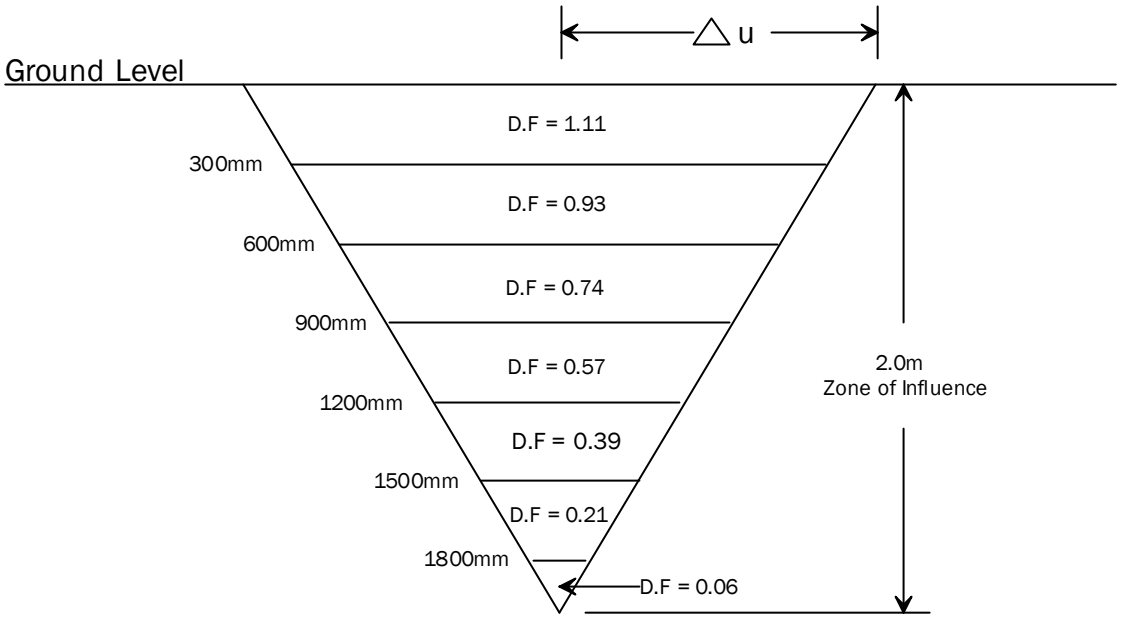
EXAMPLE

P.L.M. (Predicted Layer Movement) = M.P. x D.F. (Depth Factor) x 10

Linear Factor x Layer Thickness x Depth Factor x Linear Shrinkage = Predicted Layer Movement

Y's = Sum of P.L.M

For a "zone of influence" of 2 metres



***Soiltest Australia Engineering Services Pty Ltd calculates the Ys using both shrink/swell and atterberg test method. In the foundations design criteria the worst of the two results are used in the calculation of potential foundation movement.**

2.04 SITE MAINTENANCE

The performance of the footings and/or slab is largely dependant upon a responsible approach by the builder and the owner/occupant towards vegetation and site drainage. It is not recommended to have trees within a distance from the residence equivalent to:

75% of the mature tree height, for class “M” sites
100% of the mature tree height, for class “H” sites
150% of the mature tree height, for class “E” sites

Alternatively, root barriers MUST be adopted if the removal of some trees is not possible. A root barrier is usually installed between the foundations and adjacent trees within their mature height from the foundation and where there is expansive clay soil to prevent tree roots from consuming moisture from the soil under the area of concern.

Root barriers can be made of any impermeable durable material that can withstand burial in soil for an extended period of time.
The depth required for the root barrier is greatly dependant on the tree species, as the root systems on different tree types will vary in depth at which they are embedded. It is recommended that a qualified horticulturist be consulted prior to the installation of a root barrier if there is concern for the health of the tree who’s roots are to be cut.

Removal of large trees may cause an adverse affect, as soil moisture is gradually restored, this may cause clays to swell and may lift shallow footings. Water MUST never be permitted to pond around foundations.

Additional Critical Issues are:

- Water must not be permitted to pond in or around footings
- Garden Beds adjacent to the house should be avoided
- The development of gardens should not interfere with effective site drainage
- Moderated watering of the garden is preferred to indiscriminative neglect and/or irregular saturation
- Plumbing leaks and in particular damaged storm water pipes should be repaired promptly
- Grated drain inlets are to be positioned under exterior taps which are located adjacent to the residence

The previously mentioned restrictions may seem onerous for new home owners, however the lack of site maintenance on a reactive clay site can cause damage to the house. The damage to houses caused by reactive clays is mostly unsightly cracks in the brickwork. In the typical Australian brick veneer house, the brickwork does not support the structure. It is the timber frame that carries the walls and roof loads, so brick cracks do not affect the structural safety of the house.

2.05 SUB SURFACE MINING/SLOPE STABILITY

Unless Soiltest Australia Engineering Services Pty Ltd has been instructed to the contrary, findings and recommendations contained in this report are not relevant should existing or proposed mining projects and/ or slope instability adversely influence the ground conditions.

2.06 BATTER ANGLES FOR EMBANKMENTS

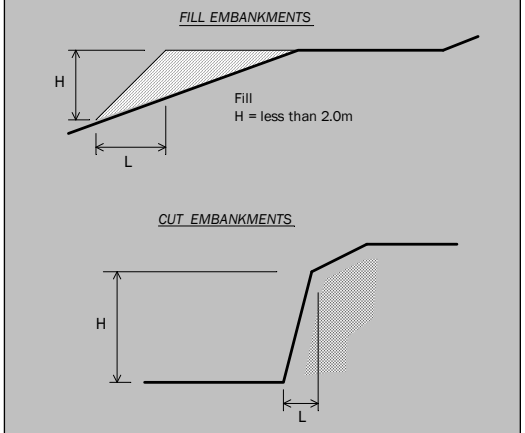
Batter angles must comply with local government requirements and are to conform as follows;

2.07 FILL MATERIAL AND COMPACTION

For totally filling the pad to level, CBR 15 or decomposed rock is recommended. Fill placed behind a brick cavity is to be of a granular base consisting of either sand, CBR 15, decomposed rock or “crusher – dust”. Highly reactive clay based soil is not recommended for use as fill. Fill is to be placed in 150 mm deep layers, moistened and compacted to achieve the equivalent of 95% standard compaction. Compaction testing is to be in accordance with AS 1289, section 5.2.1. A vibrating “sheeps-foot” roller is recommended for compaction of the totally filled pad. A “vibrating-plate” or a “wacker-packer” is recommended for compaction of fill restrained by a brick-cavity.

Note; Fill is not to be compacted within 500 mm of the brick cavity base (retaining wall).

Note : Retaining walls or other form of soil retaining methods must be adopted where the slope ratio is greater than that indicated in the table below :-



MATERIAL TYPE (refer soils report)		EMBANKMENT SLOPES (Height : Length)	
		Compacted Fill	Cutting
Stable Rock (A*)		2 : 3	8 : 1
Sand (A*)		1 : 2	2 : 3
Silt (P*)		1 : 4	1 : 4
Clay	Firm Clay	1 : 2	1 : 1
	Soft Clay	Not Suitable	2 : 3
Soft Soils (P*)		Not Suitable	Not Suitable

2.08 EXISTING / PROPOSED SERVICES

Existing or proposed services may have an impact on the design recommendations supplied by the designing engineer. Therefore it is strongly recommended that you contact the local authority and confirm the positioning of any underground services that may be on site prior to any proposed excavations.

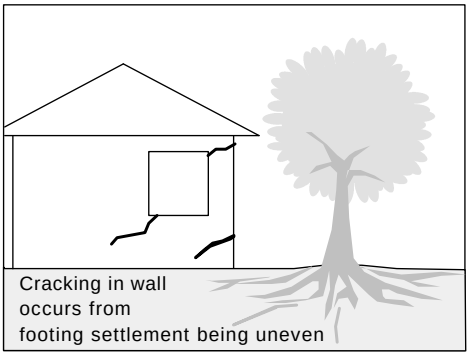
2.09 OTHER STRUCTURES

Excavations, retaining walls, swimming pools and other structures which are built near the proposed building after its completion may change the soil conditions and Soiltest Australia Engineering Services Pty Ltd or another engineer must be consulted prior to any such work being undertaken. Should soil conditions vary significantly from those indicated in this report, or if the proposed building design or proposed site preparation details are changed, Soiltest Australia Engineering Services Pty Ltd is to be contacted immediately in order to present amended recommendations.

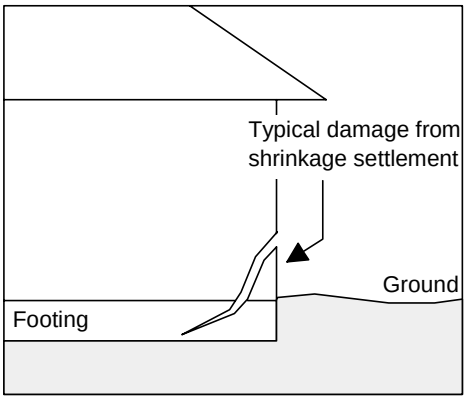
2.10 ROOT BARRIERS

Root Barrier Requirements

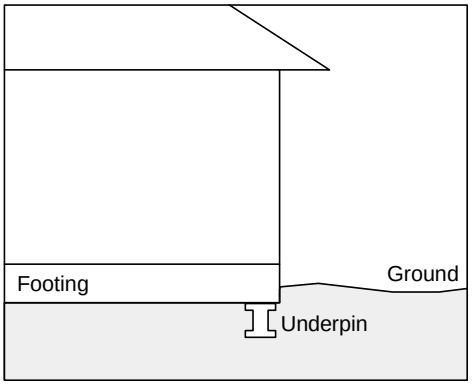
Trees and large shrubs require amounts of water to survive. Tree roots absorb moisture from in the soil, and as soils dry around the root systems they will naturally extend and grow in the direction of soil moisture. This drying out of soil can cause considerable movement of the ground level, especially when combined with highly reactive (clay) soils can result in uneven settlement of foundations. This uneven settlement may cause substantial damage to the foundations of building and walls as well as driveways & pathways. After damage has occurred, underpinning of footings and more costly repairs (even the most drastic, demolition) is often the only option.



Wall Cracking



Local corner settlement



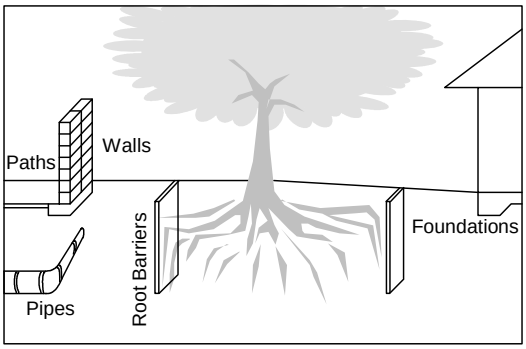
Underpinning

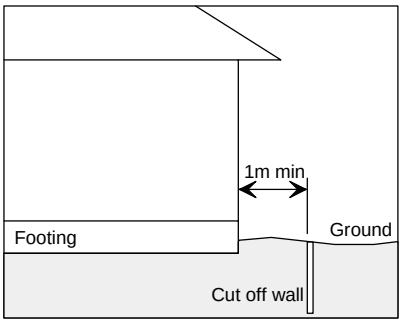
Installation of Root Barriers will protect house foundations as well as pipes, walls and paths and will eliminate the problem of uneven settlement of foundations. With the installation of a Root Barrier, trees which in the past had to be removed because of their damaging effects can remain and exist quite happily alongside of buildings without causing any problems underground.

It is not recommended to have trees within a distance from the residence equivalent to;

- 70% of the mature tree height, for Class “M” sites
- 100% of the mature tree height, for Class “H” sites
- 150% of the mature tree height, for Class “E” sites

Where trees are located within the recommended distances outlined above, the construction of a vertical cut-off wall will be required to effectively prevent tree roots from gaining access to structures, therefore stabilising the soil by greatly reducing moisture movement. The vertical cut off wall should be constructed a minimum of 1 metre from the footings of the structure and generally 1 metre in depth, however this may depend on soil types.

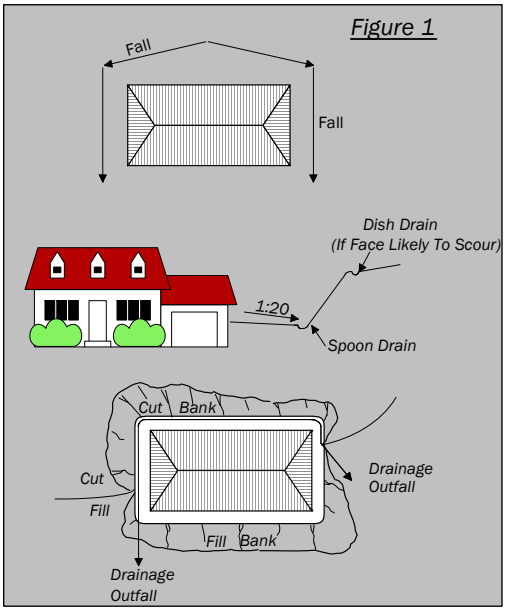




Cut-off wall

2.11 SITE DRAINAGE

Site preparation must include provision for a ground fall of no less than 1 in 20 away from the house for a distance of at least 1 metre and where possible, a spoon drain at the base of cut banks directing surface drainage around and away from the footings. Refer to figure 1;



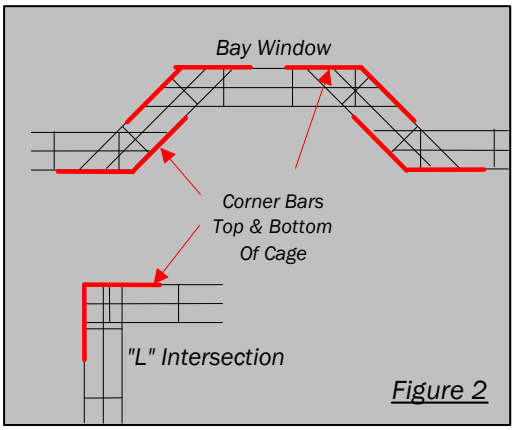
2.12 FLOOR TILES REQUIREMENTS

When it is proposed to adopt the use of floor tiles it is recommended that:

- tiles are not laid for a minimum period of two months after the slab has been poured.
- the slab is cured
- flexible adhesive and flexible grout is adopted
- for the extensive use of tiles, a system of expansion joints should be used to divide up the floor area into grids to minimise the potential problem of tile growth / shrinkage.

2.13 REINFORCEMENT DETAILS

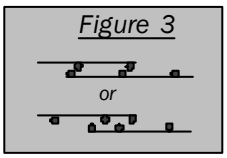
Steel wire reinforcing fabric and bars are to conform with A.S. 1304, *("Hard Drawn Steel Wire Reinforcing Fabric For Concrete")* and A.S. 1302 *("Steel Reinforcing Bars For Concrete*").



Lap Lengths

- Trench Mesh: 500mm in a straight line, or to the far face at "T" & "L" intersections.
- Steel Bars: "Y" Bars:- 35 times the bar diameter. "S" bars:- 50 times the bar diameter.
- Corner Bars: required at "L" intersections and bay windows on all sites. Refer figure #2

NOTE: On class "H" sites a special bay- window footing may be required.



- Slab Fabric: One full panel of the fabric, so as the two outer-most transverse wires of each sheet are overlapped, as shown in figure #3.

Reinforcement Alternatives

Numerous *(not all)* alternatives for footing and slab reinforcement are indicated on the footing/slab design detail. Should a preferred reinforcement not be specified, you must contact Soiltest Australia Engineering Services Pty Ltd for confirmation as to it's acceptability.

2.14 ARTICULATION REQUIREMENTS

Masonry like rock or concrete is brittle and weak in tension. Therefore, it is affected by distortions causing tension or tensile stresses. There are two essential causes of distortion which can cause tensile stresses.

- Movements within the masonry itself from expansion or contraction.
- Movements of structural elements which support or are supported by the masonry.

Movements Within Masonry

These movements are caused by:

- Expansion of clay bricks
- Shrinkage of concrete masonry
- Thermal movements

Usually in small buildings thermal movements in masonry are of little consequence. However, the expansion/shrinkage characteristics may be of importance.

If suitable precautions are not taken, the result of distortions within masonry may take place. Sometimes in small buildings it may be unnecessary to take any particular precautions, and at other times it may be essential if cracking is to be avoided.

Expansion of Clay Bricks
All clay bricks expand over a long period after leaving the kiln. This may continue for many years. The amount of expansion varies considerably between varieties of brick being affected by the raw materials used in manufacturing the bricks and the burning in the kiln.

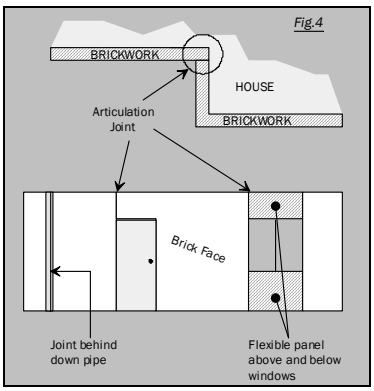
Shrinkage of Concrete Masonry
Concrete blocks and bricks shrink. If not allowed for in construction, this would result in cracking. This is caused by the bricks drying out. Moisture is obtained in these ways.
(i) Manufacture and curing of units
(ii) Wetting of bricks / blocks from rain or by block-layers during construction
(iii) Rain on walls immediately after laying and before masonry is complete
If mortar is weak, shrinkage effects are likely to be localised through some bond failure around each block. Strong mortar result in large shrinkage cracks occurring at intervals determined by the block shrinkage and wall characteristics.

Movements From Supports - General Aspects
Sources of Movement
Masonry walls sit on supports which are nowadays usually of concrete. The concrete may be a footing seated on the ground or foundation or a suspended beam or slab carrying the wall loads between other support. Footings may be distorted by foundation movements either from settlement or differential movement due to shrinkage or expansion in the foundation soils.

Forms Of Movement
Stresses at corners of openings are known to be very high and will cause cracking with only very small movements. By eliminating such corners and breaking all masonry into rectangular panels, the full available strength of the masonry panel can be used. Tensile stresses in such a panel will be much smaller than at corners of openings and therefore cracking is much less likely.
The technique of breaking masonry construction into separate rectangles joined by panels which allow relative movement is called 'Articulation'.

Special Methods of Construction
From the preceding sections, it can be seen that to reduce or prevent cracking, it will be necessary to take the following actions

- To articulate masonry elements to eliminate or greatly reduce the likelihood of cracking.
- To provide additional control joints to cater for expansion or shrinkage where the masonry materials requires.
- To arrange walls in a sensible grid pattern
- To provide an adequately constructed roof system which will not transfer horizontal loading to walls.



Where to Articulate
Wherever large openings occur the masonry is jointed. Over doors and windows it is simpler to have panelling rather than masonry. Below windows masonry is usually preferred. Where potential support movements are large, plastered masonry below windows must be jointed. In some circumstances on less reactive soils the movements are not sufficient to cause cracking in masonry which is continuous below windows. Where openings are small (as at bathroom windows, for example) there may be sufficient depth of masonry above and below the window to reduce the likelihood of cracking. It is generally acceptable not to articulate below such windows. For more information please refer to 'Cement & Concrete Association' note TN61.