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AWGEOTECHNICS

AS2870-2011 SITE CLASSIFICATION

CLIENT:
Fairmont Homes
1/79 Lasso Road
GREGORY HILLS NSW 2560

SITE ADDRESS:
No.183 Barrenjoey Road, Newport NSW

SITE PHOTO:

DATE: 3 February 2021 Revision: A

Our REF: AWT61715

AS2870 Site Classification
Class P
y_s Range (normal)
31-40mm
Estimated AS4055-2012 Wind Classification
N3

The pages that form the last six pages of this report are an integral part of this report. The notes contain advice and recommendations for all stakeholders in this project (i.e. the structural engineer, builder, owner and future owners) and should be read and followed by all concerned. If there is any doubt whether this report is complete, please check with our office. This report is subject to the terms and conditions set out below.

SITE SPECIFIC FEATURES

Site Features:	Vacant site with grasses and trees
Site Drainage:	Poor (At time of testing)
Ground Slope	Gentle
Proposed Earthworks:	Assume 50/50% Cut/Fill
Ips Value:	TS2 (700-1000 mm) = 2.6%
y_s :	31-40mm
H_s:	1800mm
Water Table/Seepage:	Not present
Fill:	Yes (uncontrolled)
Rock:	Yes (1000mm at TS1 and 1600mm at TS2)
Slope Instability Assessment:	Not commissioned

ALLOWABLE BEARING PRESSURE

NATURAL

250kPa:	Soil/bedrock interface
400kPa	500mm and deeper into XW-Rock

DESIGN GUIDE FOR BUILDER ESTIMATION PURPOSES ONLY*

Design Slab Class*	**Class M**
Piering Required:	**Yes** Reason: **Fill/Trees**
Piers (Min depth)**	TS1 – Rock TS2 – Rock
Plumbing Requirements	Articulated / Flexible Joints: **No**

Please note that should additional information become available that was not supplied or known at the time of our testing, we reserve the right to revise this report without penalty.

*For the purposes of this report, this is an estimation only and is subject to change on review of a qualified structural engineer based on the information contained within this report.

** *± Predicted cut/fill depths*

SITE SPECIFIC NOTES

We have classified the site as **Class P** in accordance with AS2870-2011.

Abnormal Moisture Conditions

Using the guidelines in AS 2870-2011 we have derived a normal ys in excess of 20 mm (refer front page), which is a measure of the potential of the strata to change volume with changes in soil moisture (generated by seasonal moisture variations).

During the site visit, we also noted features (see front page) within the zone of influence of the proposed building footprint, which are specifically mentioned in Clause 1.3.3 of AS 2870-2011 as contributing to abnormal moisture conditions (AMC). Clause 2.1.2 specifically notes that AMC sites require a "P" classification and AS 2870-2011 offers the following advice to the footing designer on the impact of AMC conditions.

Clause 1.3.3 (in part) "Buildings constructed on sites subject to AMC have a higher probability of damage than that given in Clause 1.3.1"

Clause 1.4.1 General The design conditions specified in Clauses 1.4.2 and 1.4.3 for beams and slabs supported by the foundation on normal sites shall apply.

For other than normal sites, the design of the footing system shall be by engineering principles to ensure the footings perform in accordance with Clause 1.3. Design considerations that are particular to the site shall be considered.

Clause 1.4.3(b) "Past satisfactory performance of similar footings on similar sites"

As the above quoted normal ys does not take into account ground movements generated by the abnormal conditions, the design engineer must use his/her experience and judgment to ensure that the design provides acceptable performance. In doing this, the following must be considered:

- How the proposed development will change the existing equilibrium of the soil moistures.
- The long term impact on the soil moisture equilibrium of existing and future vegetation and structures.
- Appendix H and/or CH of AS2870-2011.
- Effective site drainage.
- Past satisfactory performance of similar footings on similar sites.

As the above quoted "normal" ys does not take into account the additional ground movements generated by the "abnormal" conditions, the design engineer must use his/her experience and judgment to ensure that the design provides acceptable performance. In doing this, the following must be considered-

- How the proposed development will change the existing equilibrium of the soil moistures.
- The long-term impact on the soil moisture equilibrium of existing and future vegetation and structures.

Where vegetation exists within the zone of influence of the proposed footing system, the design engineer shall consult Appendix H and/or Appendix CH of AS2870 in order to provide a suitable structural design.

If piers are preferred in lieu of increasing the stiffness the full slab, below is a design guide for estimating purposes only.

Normal y_s	Estimated Design Class	Piers
31-40mm	Class M	Rock

Old Fill

The fill on this site was placed many years ago, prior to construction of the existing houses on adjacent lots. At the time of these earthworks, the fill was probably compacted to the standard of the day, but certifying documentation (if any) would not comply with today's standards so this fill cannot be classified as "controlled" as per AS 2870-2011.

We have therefore defined this fill as uncontrolled. This is not to say that the fill is inadequate, it is a statement about the lack of documentation and by definition we must classify this site as Class P.

Slope Stability

There are some areas nearby which the local authority may believe to be subject to landslip. Although our commission has specifically excluded consideration of landslip, this does not exclude the possibility that the local authority may request a Slope Stability Assessment for this project, nor does it exclude the possibility that during estate development modifications to the site may have masked any indicators of previous instability.

Water Table

Although no water table was encountered during our testing, a perched water table or water seepage can occur during or after wet periods, generally where a porous layer overlies less porous strata. This generally results in some water seepage into excavations down to this level, but a competent contractor can usually resolve this issue

Other Considerations

Prior to construction, our classification assumes all topsoil/estate dressing and any debris including organic vegetation is stripped clear from the building platform.

Warning: Our classification has not allowed for any future tree(s), which may be planted as part of the future landscaping. The owner, future owners and any stakeholder/consultant who is involved in the landscaping, has a duty of care to ensure that any future planting does not adversely affect the proposed dwelling and both Appendix H and CH AS2870-2011 and the referenced CSIRO documents give guidance on "Acceptable Long Term Site Management". Therefore, it would be prudent for any such proposal to be presented to the design engineer as soon as it is available, to ensure that the design engineer is satisfied that the landscaping proposed will not adversely affect the footing system.

Note: Cutting and filling the site by depths equal to or greater than 400mm will result in a 'P' classification, which may increase the design 'ys'. Therefore, when the proposed cut and fill earthworks is known, we shall be forwarded the earthworks plan to determine the potential impact on the above recorded calculations.

Unless specifically mentioned elsewhere within this report, we make no representation about the trafficability of the site during construction, however the thicker the topsoil/estate dressing, the greater the problem with moving construction equipment during or after rain periods.

AW Geotechnics

Jason Bau
MIE Aus, NER, RPEQ

BORELOGS

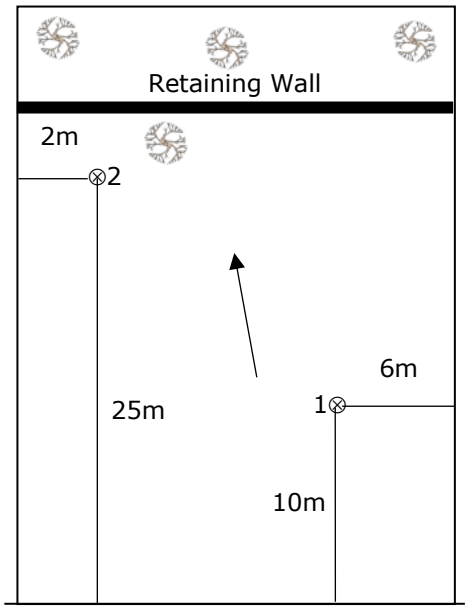
TEST SITE 1					TEST SITE 2				
Depth (mm)	Description Soil Type-Colour-Consistency	FILL	DCP	PP kPa	Depth (mm)	Description Soil Type-Colour-Consistency	FILL	DCP	PP kPa
100	FILL – gravelly silty clay		1		100	FILL – gravelly silty clay		2	
200	(gy/or/rd)		2		200	(gy/or/rd)		3	
300	sl moist		4		300	sl moist		2	
400			3		400	SANDY SILTY CLAY		2	
500			2		500	(gy/or)		2	
600			4		600	sl moist and stiff		2	
700			6		700	SANDY CLAY with gravel		3	
800			4		800	(gy/or/rd)		2	
900			5		900	sl moist and stiff		3	
1000			17		1000			4	
1100	XW ROCK		+25		1100			5	
1200	(gy/or)				1200			4	
1300	dry and low strength				1300			6	
1400					1400			6	
1500					1500			8	
1600	- dry and med strength				1600			12	
1700					1700	XW ROCK		22	
1800					1800	(gy/or)		+25	
1900					1900	dry and low strength			
2000					2000				
2100					2100				
2200					2200				
2300					2300				
2400	UTP DW ROCK P/A				2400				
2500					2500				
2600					2600				
2700					2700				
2800					2800				
2900					2900				
3000					3000				
3100					3100				
3200					3200				
3300					3300	XW ROCK			
3400					3400	(gy/or)			
3500					3500	dry and med strong			
3600					3600				
3700					3700				
3800					3800				
3900					3900				
4000					4000				
						END P/A			

NOMENCLATURE: UTP=Unable to Penetrate DCP=9kg Dynamic Cone Penetrometer PP = Pocket Penetrometer A=Auger XW-ROCK=Extremely Weathered Rock Refer Tables 7.3.2 & 7.3.3 AS1726-1993 gy=grey or=orange yell=yellow rd=red wh=white brn=brown bk=black bl=blue gr=green Refer AS1726-1993 Clause A2.4 for classifying soils.

Notes:

1. Hand Auger is a portable auger and where utilised is used because of lack of access or trafficability, it is essential that the results of a hand auger are confirmed once access is provided, further testing using a 4WD mounted drill rig is carried out, or stakeholders shall accept the associated risk of results which may not represent the subject site conditions.
2. 9kg Dynamic Cone Penetrometer can be unreliable in certain soils which may include (but not limited too), cohesive soils, soils which may contain gravels with a grain size in excess of 10mm, and strata with allowable bearing pressures in excess of 400kPa.
3. *Pocket Penetrometer readings are an unfactored field strength test and should not be assumed equates to an allowable bearing pressure.*

SITE SKETCH (Not to Scale)



SITE PHOTOGRAPHS

AERIAL PHOTOGRAPHS

UNDERSTANDING THIS REPORT

The soils encountered on this subject site have been identified as expansive/reactive soils which have a potential to change volume with changes in soil moisture.

These soil moisture variations can be generated naturally (by rain or lack of rain), by nearby vegetation, either new plantings, existing tree(s) being removed or allowed to continue to grow, or by poor site drainage, where water is allowed to pond or accumulate near the footing system. Another significant cause can be broken or damaged service pipes which carry water near or under the dwelling. These factors are outlined in AS2870-2011, Section 1.1 and are known as: “Abnormal Moisture Conditions"

In preparing this report, we have used our experience and current scientific knowledge to determine the various parameters needed by your Engineer to design an economical footing system which will provide serviceability within the AS2870 performance criteria for the life expectancy of the dwelling.

At the time of our testing we had an understanding of the soil moisture content, and we derived a ‘Design Movement’ value in ‘mm’. We then use to following matrix to arrive at a ‘Risk of’ potential for this site:

Potential for Long Term Uplift (Heave)

	Wet MC>>PL	**Moist** MC>PL	**Neutral** MC=PL	**Slight Dry** MC<PL	**Dry** MC<<PL
< 20mm	Not Creditable	Very Low	Low	Low	Moderate
21-40mm	Very Low	Low	Moderate	Moderate	High
41-60mm	Low	Low	High	High	Very High
61-75mm	Low	Moderate	Very High	Very High	Extreme
76-100mm	Low	Moderate	Extreme	Extreme	Very Extreme
> 100mm	Low	Moderate	Very Extreme	Very Extreme	Very Extreme

Potential for Long Term Settlement

	Wet MC>>PL	**Moist** MC>PL	**Neutral** MC=PL	**Slight Dry** MC<PL	**Dry** MC<<PL
< 20mm	Moderate	Low	Low	Very Low	Not Creditable
21-40mm	High	Moderate	Moderate	Low	Very Low
41-60mm	Very High	High	High	Low	Low
61-75mm	Extreme	Very High	Very High	Moderate	Low
76-100mm	Very Extreme	Extreme	Extreme	Moderate	Low
> 100mm	Very Extreme	Very Extreme	Very Extreme	Moderate	Low

General Notes

This is a site classification report generally in accordance with AS 2870-2011 and should be sufficient for a qualified person to design footings for structures covered under the scope of this standard.

Where our proposed earthworks specification states "Unknown", AS 2870-2011 Clause 2.5.2 requires the site to be reclassified prior to footing construction if the proposed cut exceeds the lesser of $0.25H_s$ or 500 mm and the proposed fill exceeds the limits in Clause 2.5.3 of AS 2870-2011. In these instances, the site classification is in the "as tested" state and may not reflect the final site classification after earthworks. Normally this re-classification is done by the design engineer, but upon request, we can do this. Where the site preparation is stated as "known", our classification is based on the data given, as we envisage the finished building footprint (which conforms to the AS 2870-2011 guidelines), therefore re-classification is only required if these guidelines change. This report may not be adequate for large complex dwellings that are generally outside the scope of AS 2870-2011.

AS 2870-2011 contains a system of classifying soils based on their ability to change volume with changes in soil moisture. These classes are Class A, Class S, Class M, Class H1, Class H2 and Class E (the most severe). These "Normal" classes also have a minimum allowable bearing capacity as outlined in Clause 2.4.5 of AS 2870-2011.

AS 2870-2011 also has a Class P for problem sites covering fill, soft or collapsing soils, potential slope stability problems, mining subsidence and abnormal moisture conditions. Abnormal Moisture Conditions (AMC) is a particularly contentious area and Clause 1.3.3 of AS 2870-2011 covers many situations where this clause applies. The most common situations are sites with clay soils (normally Class M, H1, H2 or E (ys > 20)) that have either existing structures or trees or gardens within the zone of influence of the proposed footing. Some of these trees may be on adjoining properties. Where this clause is applicable, we have added further explanatory advice. The soil shrinkage index (lps) range quoted in this report was assigned after considering the guidelines in Section 2 of AS 2870-2011 and from this we have derived a ys, which is the "characteristic surface movement" under NORMAL moisture conditions.

Footings designed in accordance with AS 2870-2011 have a long-term performance criteria and it should be noted that this does not offer a crack or distress-free performance. It offers a performance criterion that ensures a low probability of foundation failure, provided abnormal moisture conditions, such as over-watering, bad drainage, leaking pipes or nearby trees are not allowed to exist or develop.

These performance criteria are outlined in Appendix C of AS 2870-2011 and under normal conditions a low incidence of Category 1 damage and an occasional incidence of Category 2 damage is expected. This appendix is available from our office upon request.

Where Abnormal Moisture Conditions exist and/or are allowed to continue to develop, then not only will the above probabilities increase, but the damage will be greater. The ultimate responsibility falls on the design engineer to negate the effects of these conditions when they are known and for the owner/occupier to ensure that they do not develop. Our responsibility is limited to identifying these conditions. If any potential owner is not satisfied with the performance criteria in AS 2870 (which has been applied Australia wide since 1986) then prior to footing design, he/she should consult with the design engineer and have a specially designed footing more suited to their needs.

Classification Limitations

The content of this report is based on the expertise and experience of the author representing this company. Our commission didn't extend to assessing instability due to previous or existing sub-surface mining, landslip or earthquakes, nor did it extend to testing to comply with the relevant contaminated land act or for acid sulphate soils (see note below). If, however any of these exclusions was obvious or where the allotment is within an area where we are aware of a past history of these exclusions, we have made comment and given further advice. This report is based on the assumption that the test results are representative of the true site conditions. Even under optimum circumstances, actual conditions may differ from those reported to exist. Although our investigation exceeds the minimum requirements of AS 2870-2011, economic constraints necessarily limit the practical extent of any investigation. We therefore cannot accept responsibility for conditions encountered on this site outside the areas tested which are different to those reported. The positions of these test sites have not been surveyed and should be regarded as approximate. We have followed AS 2870-2011 soil descriptions contained in Clause C2.1 rather than AS 1289 because where there is a conflict between referenced codes, AS 2870-2011 takes precedence.

Underslab Termiticide Irrigation Systems

These are becoming popular and besides serving their obvious purpose, they also inject extra moisture beneath the slab at various times (measured in years). This creates long term "abnormal" moisture conditions that needs to be addressed at the design stage, therefore if one of these is proposed for this project, the design engineer must be informed prior to preparing the slab. As a general rule, to cope with these systems, the ys must be increased by about 50%, which will generally result in a slab one category higher than would normally be used (refer P12, Supplement to AS 2870-2011). Upon request we can supply more specific advice.

Acid Sulfate Soils (ASS) & Saline Soils

Unless specifically stated, we have not considered the possibility of ASS, which occur around the coastline, generally below AHD 5.0 and occasionally on broad river flood plains at higher levels. Most Councils maintain maps of these areas. In new estates the ASS problem has normally been assessed and neutralised, but it is worthwhile confirming this at land sales, if ASS are suspected. In older areas, the council is normally the best source of advice. ASS, if present, do have the potential to dramatically shorten the life of footings, slabs, reinforcement and bricks. This advice is also relevant for saline soils. Unless specifically stated, we have not considered the possibility of Saline Soils, however we can provide a quotation to complete this testing.

Filled Ground

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 AS 3798-2007 Clause 6.4.2 of AS 2870-2011 defines controlled fill.

Uncontrolled Fill - Fill that does not have sufficient documentation to be classified as controlled is by exclusion, uncontrolled. Where found we have offered further advice within this report.

Topsoil/Estate Dressing

In our soil log section, where we have logged "Topsoil" or "Estate Dressing" it is defined as per clause 1.2.15 of AS 3798-2007 thus:

"A poorly compacted superficial soil containing some organic matter, usually darker than the underlying soils"

Good building practice dictates that all heavy organic strata be scraped clear of the building envelope during the early stages of site preparation and we have assumed that this will be done.

Short Term Site Management

This is the responsibility of the builder, and besides ensuring that the site is handed over to the owner at completion in accordance with accepted practice, the following should also be done:

- Ensure all service trenches are back-filled as soon as possible in accordance with Clause 6.6 of AS 2870-2011, including the clay plug where a service pipe trench exits the building footprint.
- Ensure guttering is connected to the stormwater (via temporary pipes if necessary) as soon as the roof is on.
- Ensure that during construction and at the time of hand-over that the site is maintained as per Clause 5.2.1 of AS 2870-2011.

If any of these practices are not carried out, the site may develop "abnormal" moisture conditions, increasing the risk of damage above the AS 2870-2011 criteria.

Other Construction Issues

The builder must also ensure that other sub-trades such as plumbers, drainers and swimming pool contractors don't establish excavations within the critical zone of influence of the footing system unless the footing is piered below the influence of these excavations. This critical zone varies from 20° (1V:2H) to 45° (1V:1H), depending on the nature of the strata. If this situation is considered possible, then once the proposal is known we can offer further advice. These excavations include inground tanks. Unless we have specifically given written approval, no inground tanks should be sited within 8 metres of any structural footing.

Furthermore, there should be no in ground disposal or storage of water, (i.e. soakage pits, rubble pits, rain gardens or similar), within eight (8) metres of a structural footing, without our prior written approval.

Where the proposed earthworks involve the establishment of cut/fill batters, advice concerning safe angles is beyond the scope of commission in this report. AS 2870-2011, Clause 6.4.4 offer guidelines.

Long Term Site Management

It is the owner's responsibility to ensure both tenants and future owners are aware of these responsibilities. The referenced CSIRO sheets outline these responsibilities and if the builder does not give the owner a copy, they can be sourced from either the CSIRO (1800 645 051) or our office.

The major danger to dwellings is allowing site conditions to deteriorate to "abnormal" in the long term.

Where abnormal moisture conditions are allowed to continue or to develop, then not only will the above probabilities increase, but the damage will be greater.

The CSIRO sheets define both "normal" and "abnormal" conditions.

The significant (not necessarily in order) abnormal conditions that adversely affect the performance of AS 2870-2011 type footings are:

- Trees growing or allowed to grow within the critical zone of influence of the footings.
- Poor site drainage
- Saturated service trenches (poor site drainage).
- Leaking service pipes

The builder, owner/occupier and engineer should take note that management of trees is the most difficult part of the site management procedures and trees present the greatest risk to the future poor performance of the footing system. Trees (existing or proposed) must not be allowed to grow without taking action to negate their effects within the critical zone of the footing system.

Class	Normal ys	Critical Zone
Class M	< 41mm	.75 times mature height
Class H1	41-60mm	1.0 times mature height
Class H2	61-75mm	1.0 times mature height
Class E	76-100mm	1.5 times mature height
Class E	>100mm	2 times mature height

These spacings must be increased for groups or rows of trees.

These distances are only a "rule of thumb" as the tree species and their root systems play an equally important role. Refer Appendix H and/or CH or AS2870-2011.

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Understanding soils, trees and how they can affect your house.

This document is a plain language guide to what should be expected from the construction of single dwellings, townhouses or similar structures not situated vertically above or below another dwelling. It has been compiled by the HEDRA Task Force committee in the belief that the information contained is helpful to the parties mentioned, however no warranty of accuracy or reliability as to the information is given, and no responsibility for loss arising is accepted.

1. EXPLANATIONS

Footings (often incorrectly called foundations) are the "members" that support the building. They are commonly concrete slabs or timber floors supported by strips and stumps. (Fig 1, 2 & 3).
Foundation is the soil or rock supporting the footings. **Reactive Clay foundations** are those that shrink and swell with changing moisture and cause the building and paving to sink or lift. **Reverse slope** is one that slopes towards the building. (Fig 18) **Sand foundations** do not shrink or swell but if they are loose they can cause the building to sink. **The Australian Standards** for building footing construction permits minor wall and floor movements. If the foundation conditions are changed after construction the floor and walls may move more than allowed-for by these standards. The designs for building footings in Australian Standard 2870 will perform adequately provided the building site and surrounds have "normal" foundation conditions which are maintained. If the building site and surrounds have "abnormal" moisture conditions, special provisions must be followed by the design engineer, builder and owners. **(AS2870 defines "abnormal" moisture conditions)**

The "reactivity" of clays is their capacity to shrink and swell with changing moisture and is classified as follows :

A	Reactivity absent
S	Slight reactivity
M or M-D	Moderate reactivity
H1 or H1-D	High reactivity
H2 or H2-D	Very High reactivity
E or E-D	Extreme reactivity

The greater the clay "reactivity" the greater the possibility of damage. Some minor cracking of walls is almost inevitable despite proper design, construction and maintenance. AS2870 suggests that cracks up to 1 mm wide are common and that cracks up to 5 mm may occur in clay sites subject to significant moisture changes. Some cracks are seasonal but if larger than 5 mm they are regarded as significant and should be investigated before becoming larger.

Fig. 1 Stiffened Raft

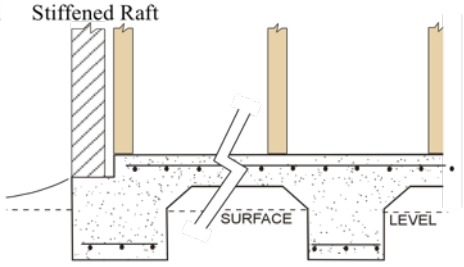


Fig 2 Waffle Slab

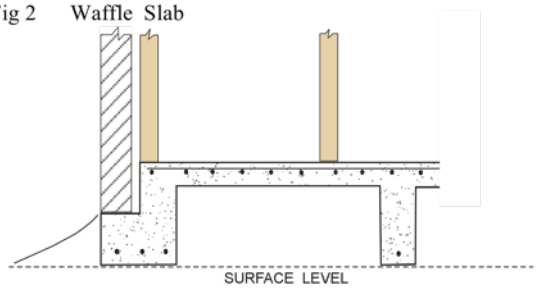
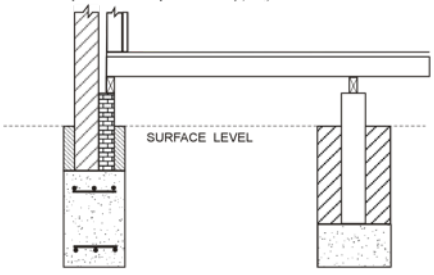


Fig. 3 Strip & Stump Footing System



2. ENGINEERING

The engineer designs house footings to ensure that they can cope with the soil and environmental conditions assessed at the time of the site investigation and perform to their design potential.

3. BUILDING

In the construction of a building the builder needs to comply the Building Code of Australia, relevant Australian Standards, engineering specifications and contract documents. (Fig. 4) The following are important aspects the builder will need to address:

- Builders should ensure that owners understand that failure to maintain adequate drainage may result in damage to the structure.
- Well-drained foundation conditions, which will create "normal" soil moisture and adequate bearing capacity.
- Ensuring that excavations are well supported or are dug to avoid collapses. (Fig. 11)
- Constructing well-compacted and retained 'soil aprons' around the building to stop erosion.
- Special considerations if any excavations are to be dug near adjoining structures.(Fig. 11)
- Sloping the soil and paths away from the building by the minimum amount required by the building regulations to prevent water flowing towards the building foundations. (Fig. 10 & 18)
- Constructing soil drains or moisture barriers in sloping sites to prevent stormwater adversely affecting the building foundations.
- In highly or extremely reactive clay sites Australian Standard 2870 – "Residential slabs and footings" requires *mechanical flexible couplings* for sub-surface drainage pipes and for above-ground connections from the downpipe to the storm water drains. These allow for the movement of the soil and minimise the risk of pipe joints breaking and creating leakage problems. (Fig.6).

4. HOME OWNERS

The home owner should read and become familiar with the Site Classification report provided prior to construction and the type of footing system used in the building. To comply with Australian Standard 2870 – "Residential slabs and footings", and achieve acceptable performance and safety during the design life of the house, the owners shall maintain the garden and foundation soil moistures, paving and drainage systems. (Fig. 7)

Failure to maintain the foundation conditions can lead to cracking of walls and floors. Damage to a building that can be attributed to actions of the owner could diminish the builder's warranty obligations, leaving the owner responsible for the cost of repairs

Fig. 4

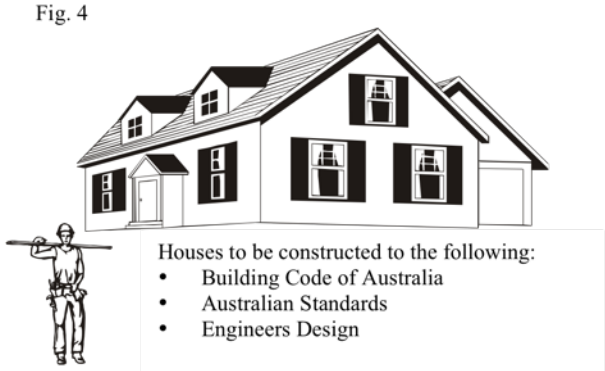


Fig. 5 Well Drained Sites

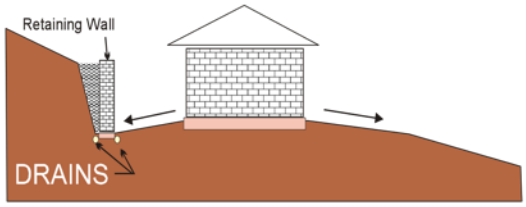


Fig. 6 Mechanical Flexible Couplings to reduce the potential of broken pipes in M/M-D, H1/H1-D, H2/H2-D & E /E-D sites plus all clay based sites with trees

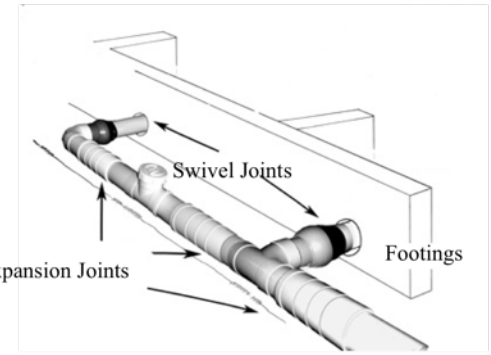


Fig.7

WORKS AFTER TAKING POSSESSION

In some cases foundation conditions are changed by the owner constructing new works such as:

- Constructing sheds or outdoor roofed areas without connecting the roof drainage to storm water lines.
- Constructing paving around the building without sufficient slope away from the building. (In sandy soils and low and moderate "reactivity" clays, a slope of 1:40 up to 1 metre away from the building is adequate. In highly reactive clays a slope of 1:20 works better. In large paved areas a drain and collection pit may be necessary). (Fig. 5 & 18)
- Australian Standard 2870, "Residential Slabs and Footings" requires soil drains and "normal" soil garden moisture in M, H1, H2, E, and P sites to be maintained by the owner. (Fig 10)
- Running machinery over shallow drain pipes may break them causing leaks and subsequent foundation movements.
- Any excavations close to building footings can cause them to sink by disturbing the foundation material or by drying the foundation clay. (Fig 11)
- Footings constructed in reactive clay sites during wet periods may be damaged if the garden is allowed to dry out excessively.
- Footings constructed in reactive clay sites during dry conditions may experience damage if the garden is watered unevenly or excessively.

5. LANDSCAPING AND TREES

Most modern allotments with clayey soils are too small to safely grow large trees without special footings. Generally the larger the root system of the tree(s) the greater the drying effect. If in doubt seek the advice of an expert arboriculturist and designing engineer.

If you are about to build in a clay area and you wish to grow, retain or remove trees near buildings, the builder should be advised of this prior to signing the building contract so that the engineer can design for these conditions.

- Trees can cause damage during their life and even for many months after their removal. If they do not receive sufficient water while alive their roots will dry the soil near buildings or under pavements.

Fig. 8 Drainage concerns

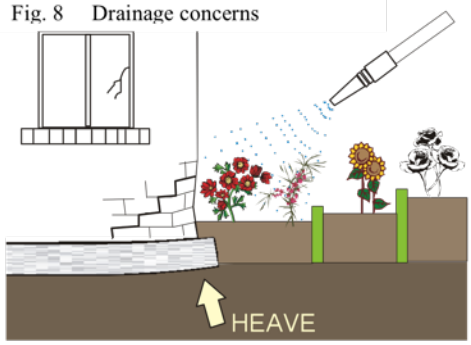


Fig. 9 Slab heave due to water ponding

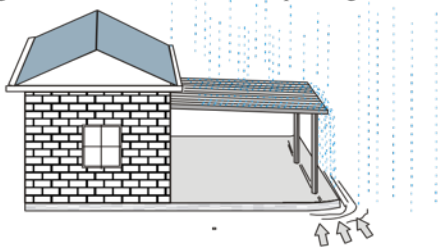


Fig. 10 Soil Drainage Plan

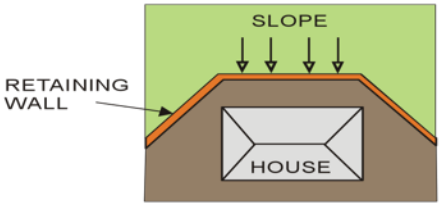


Fig. 11 De-stabilizing house foundations

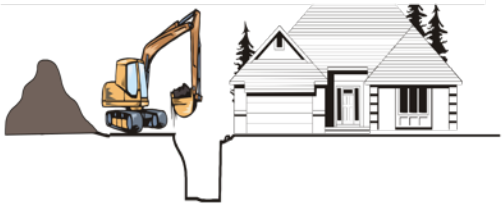
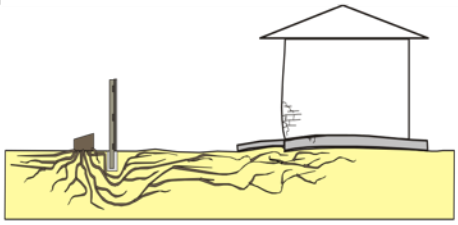


Fig. 12 Damage due to soil moisture changes



If you plan to remove trees after the building is constructed you should consult the designing engineer an expert arboriculturist or a geotechnical practitioner familiar with these problems.

Tree roots in sandy areas rarely cause any damage since sand does not shrink or swell, however if the root ball or large root is very close to a building it may grow and lift the footings of a light structure. (Fig. 13)

Foundation problems in clay sites may also be caused by :

- Excessive watering or under-watering of gardens.
- Watering systems that are overused or discharge water too close to building walls (Fig. 8)
- Constructing terraces, retaining walls or garden walls without good drainage. (Fig. 10)

6. POOR SITE MAINTENANCE

The change of foundation soil moisture is by far the greatest cause of building damage. Changes of drainage or garden watering conditions in adjoining properties can also create problems.

- A drainage system may be necessary if water flows near the building. All possible water leaks and sources should be repaired immediately, e.g.:
- Leaking or blocked roof gutters which cause water to overflow near building walls. (Fig. 14)
- Hot water systems relief valve pipes should be discharged into storm water lines. (Fig. 15)
- Air conditioners operating during hot, humid weather that discharge water near the building footings. (Fig.16)
- Leaking or overflowing water tanks near building footings. (Fig. 17)
- Land or paving that slopes towards the building and cause rain water to flow near the building. (Fig. 18)
- Water from the failure to repair plumbing leaks or leaky taps, hoses or by regularly washing cars in areas near building walls. (Fig. 19)
- Water flowing near buildings (even from neighbouring properties) must be diverted away from the footings or collected. (Fig. 20)

Fig. 13 Root Damage

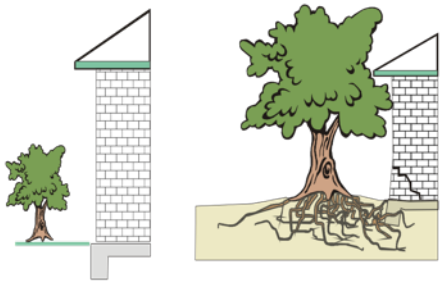


Fig. 14 Overflowing roof Fig. 15 Common leak sou

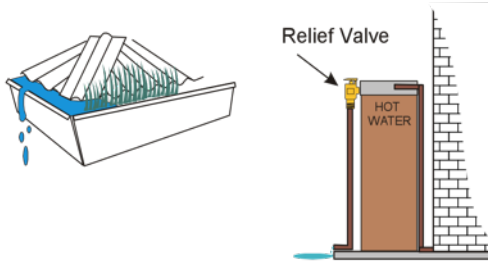


Fig. 16 Air con, up to 35 L/day loss

Fig.17 Leaky pipe

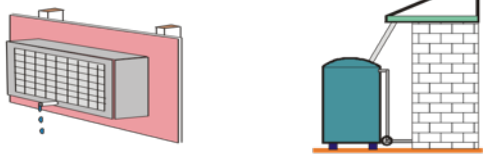


Fig. 18 Reverse Sloping paths Fig 19 Leaking tap

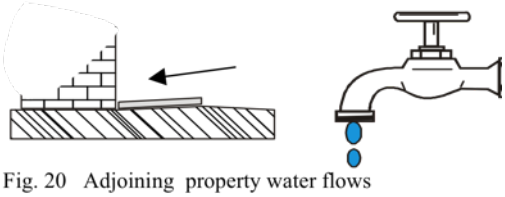


Fig. 20 Adjoining property water flows