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4th May 2018

Our ref: 4325

Attention Kelly Brown
Manager Risk & Human Resources
Ballina Shire Council
PO Box 450
BALLINA NSW 2478

Project:	Engineering Inspection & Report
Property Owner:	Robin Lowry
Property Address:	7 Castle Drive Lennox Head NSW
Ballina S.C. Work Order No:	62353

1.0 INTRODUCTION

You have advised us to inspect the property and;

1) Inspect the house and investigate cracking and movements to walls, floors or ceilings.

2) View available footing design documents and other reporting.

3) Where practicable, provide opinion on whether damages are likely to have been caused by general soil shrinkage and swelling or whether damages have been caused or exacerbated by physical pressure from tree roots and/or through roots causing soil shrinkage and building settlements.

4) Take sample levels on the building where applicable.

5) Provide descriptive recommendations for appropriate actions or repairs with specific reference to likely effects of removal of tree or tree roots.

The property was inspected on the 2nd May.

A visual inspection to the building elements that were relevant to the case and were readily accessible was undertaken. Walls and ceilings, locked rooms and floor coverings were not disturbed, for the purpose of the investigation.

2.0 PROPERTY DESCRIPTION

The house comprises;

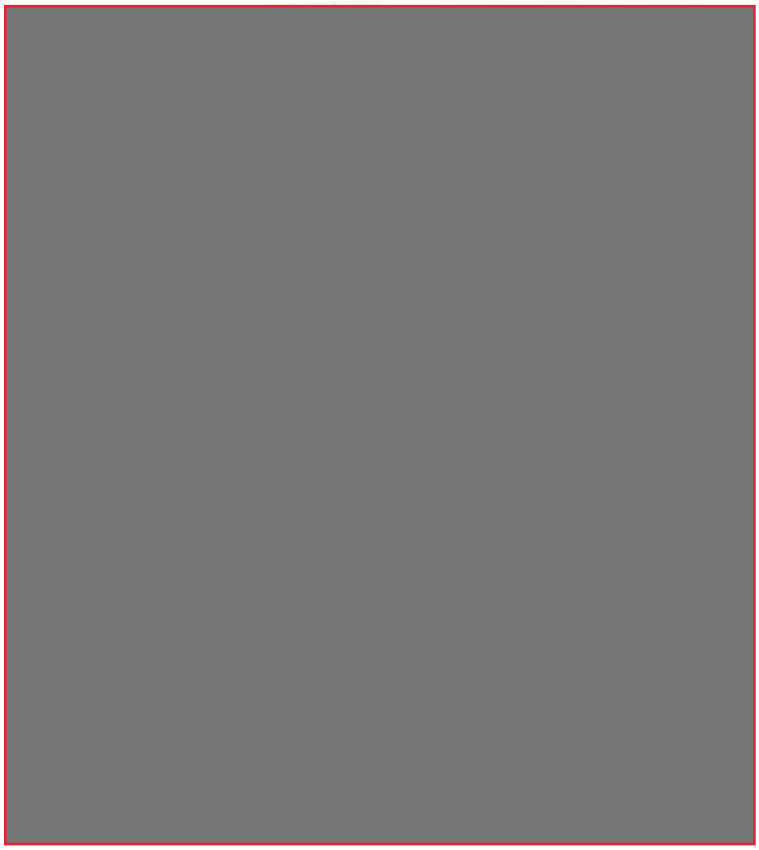
- Class 1A structure
- Single storey
- Rendered masonry veneer
- Slab on ground (waffle pod, partially piered)
- Tile roof

3.0 FINDINGS

3.1 Exterior

(Refer sketch, not to scale or dimension)

Private information



- **Driveway:** Slab vertical displacement (lifting) along control joints (in the driveway) and isolation joints (next to paths), some slab cracks also
- **Office:** South side courtyard wall rotated outwards and large gap opened at house wall abutment, concrete path slab (apparently supporting the same wall) has lifted at the northern edge wall, crack at south east corner, concrete path at western side has tilted to the west
- **Portico:** Top of column at east side has rotated slightly outwards to the south and soffit lining gap has appeared. Column also has hairline horizontal tension cracking
- **Bed 2:** Cracks (partially filled) and lateral (sideways) displacement in south end of east wall, hairline crack in south wall at east end, courtyard east wall has rotated outwards and gap has opened at house abutment
- **Tree roots:** Fig tree surface roots identified in abundance at the south east corner. Surface roots also visible at the east side of the house near Bedroom 3 / bathroom. The insured advised that tree roots had been removed from drains at the east and west sides of the house.

3.2 Interior

- No interior damages within our scope identified.

4.0 FLOOR LEVELS

(Notes; Wear and tear of floor coverings can cause variations. Garage floors often are finished with a fall to the centre and to the door. Reading locations are also limited by furniture and stored items)

We took levels on the floor and apart from some slight variations which would be “as constructed”, there are no variations of any significance, they are not excessive and level variations are within the allowed tolerance of 1:150 as determined by AS 2870 appendix C and table 4.1.

It is apparent from the floor level readings on the house that there has not been any subsidence (of any significance) from soil settlements or heave (lifting) of any significance, from soil swell.

5.0 AVAILABLE DOCUMENTATION

We have viewed the following documents;

- Approved building plans by AV Jennings, contract no 1455-03001
- Geotechnical report and house slab and pier engineering by Soiltest Australia, ref 34898-B
- Report by Craig Zerk, Engineer, ref 770108
- Report by Craig Zerk, Engineer, ref 914108
- Report by Peter Lucena & Assoc, Engineer, dated 19 August 2015
- Report by The Tree Doctor, dated 9 March 2018

6.0 WALL CRACK CATEGORIES

Wall cracks would be up to category 2 in accordance with AS2870-2011 Appendix C.

AS 2870-2011 APPENDIX C WALL CRACK CATEGORIES

Description of typical damage and required repair	Approximate crack width limit (see Note 3)	Damage category
Hairline cracks	< 0.1mm	0
Fine cracks which do not need repair	< 1mm	1
Cracks noticeable but easily filled		
Doors and windows stick slightly	< 5mm	2
Cracks can be repaired and possibly a small amount of wall will need to be replaced. Doors and windows stick. Service pipes can fracture. Weather tightness often impaired.	5mm to 15mm (or a number of cracks 3mm or more in one group)	3
Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Window and door frames distort. Walls lean or bulge noticeably, some loss of bearing in beams. Service pipes disrupted.	15mm to 25mm but also depends on number of cracks.	4

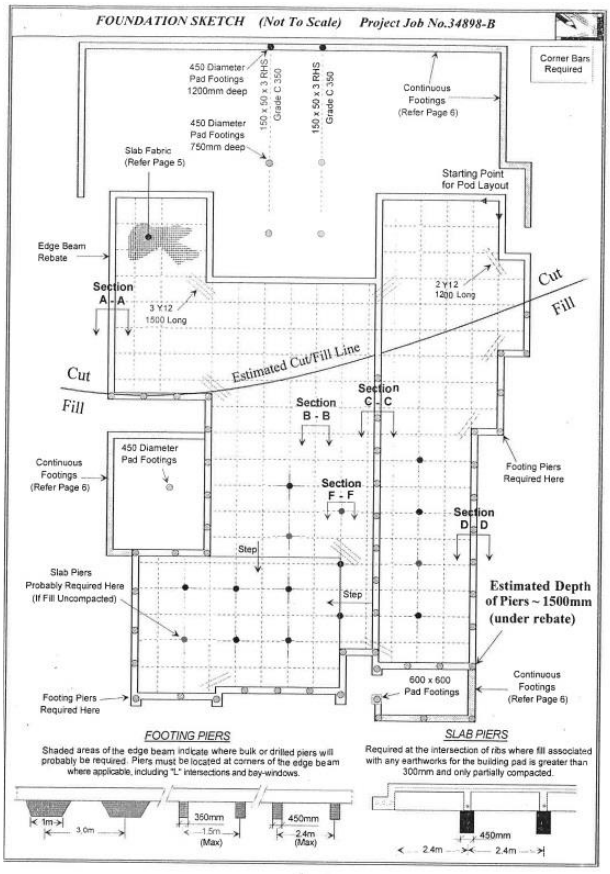
7.0 CAUSES OF DAMAGES

7.1 Foundation soil movements

We have viewed the original geotechnical report which indicates that the foundation soils (conservatively) have a moderate capacity to shrink and swell when dry and moist. In addition to this, in certain cases, the influence of tree roots can exacerbate soil moisture loss and shrinkage.

Preparation of the site for construction involved cutting into the slope at the rear (north) side and placement of landfill at the front (south) side of the platform.

The house slab and footings have been engineered to accommodate for expected shrink swell conditions as well as with the provision of supporting piers taken through landfill into solid natural ground (see foundation sketch).



Our inspection and slab level readings show that, for house slab and footings as designed by the engineers, there is no evidence that any soil swell has caused any slab centre or edge lifting (heave) of any significance and there is no evidence that any soil shrinkage or consolidation of land fill has caused any settlements of the house slab.

It should be noted that the office courtyard wall was *not* on the approved plans (see page 2), would be located on uncompacted landfill and apparently is supported only on the driveway slab with no supporting strip or pier footings.

Settlement of loose landfill under the supporting slab therefore is likely to be a contributing factor in the rotation of *this* wall.

7.2 Influence of fig tree roots

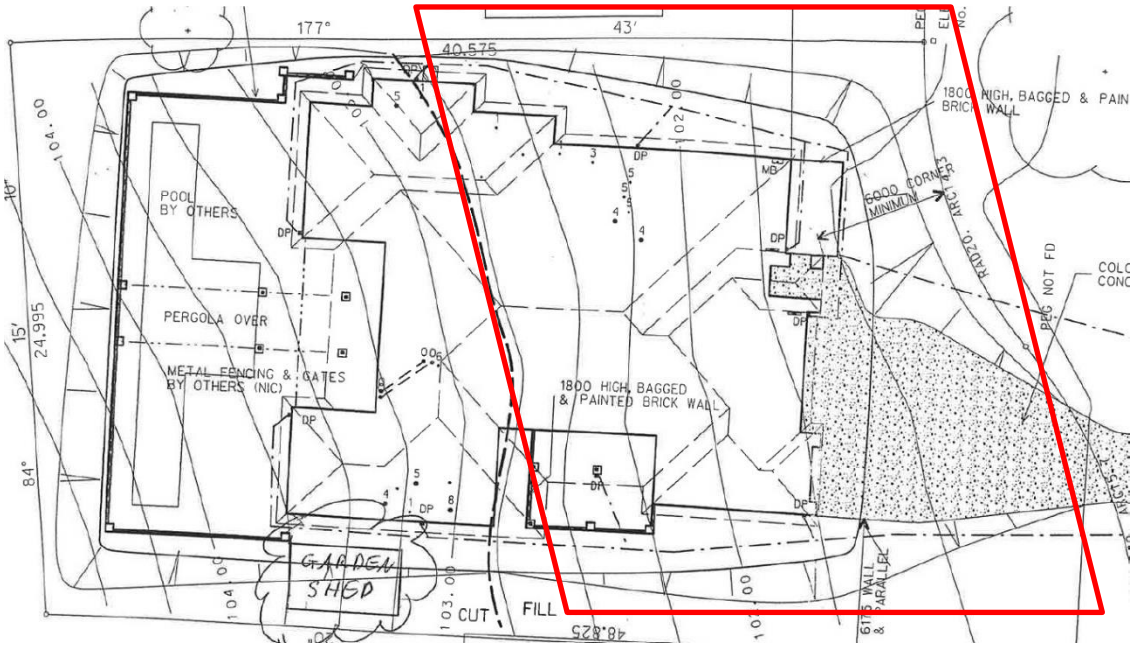
There is no evidence or likelihood that damages including; displacements of the driveway slab across joints, cracks in the house walls, rotation of the portico column, and the rotation of the Bed 2 courtyard wall have been caused by movements of the foundation soils. The floor slab level readings confirm this

The damages are located only where tree roots are located or are likely to be located.

In addition, the cracking damage of the east wall of bedroom 2 shows lateral displacement of the masonry which is indicative of some localised pressures from tree roots.

It is also significant that loose landfill (see below) was placed at the front of the building platform and under most of the driveway, and it is reasonable to consider that that this soil is permeable with elevated moisture and oxygen which promotes tree root growth and it is likely that the fig tree roots have penetrated and spread through the landfill relatively easily.

Therefore, we can find no other likely cause of theses damages other than from the spread of the fig tree roots and mechanical lifting of the driveway and parts of the house.



8.0 CONCLUSIONS

Our concluding opinions are as follows;

- Our investigation indicates that the damages have most likely been caused by mechanical lifting from the roots of the fig tree.

- Some damage of the office courtyard wall is likely to be due to settlement of loose landfill and an absence of an adequate footing and piers.

9.0 RECOMMENDATIONS

9.1 Fig tree

The tree roots can be expected to continue to spread and cause additional damages to the driveway and the house.

It is recommended therefore that, subject to an arborist's recommendations and project management, either the tree is removed or the roots are trimmed and a structural root barrier (not a conventional moisture barrier) is constructed to isolate the tree roots from the house and driveway.

The arborist may consider that root trimming could destabilize the tree and it may topple in wind events or it may die from the stress of the procedure.

9.2 Repairs

Note that there is no evidence that the fig tree roots have caused or exacerbated any significant soil moisture-related / shrink-swell movements of the driveway or the house and therefore root pruning or tree removal is not expected to result in any significant "rebound effect" on the driveway or the house.

There is no requirement therefore to delay repairs once the tree and/or roots are removed.

9.2.1 Driveway

Restoration/s of the driveway paths to "as new" condition will require replacement in accordance with the *Cement Concrete & Aggregates Australia Data Sheet Residential Concrete Driveways and Paths 2006.*

Alternatively, the elevated slab panel edges can be ground down and lower edges can be packed with dry-mix bitumen, but this method will look unsightly.

9.2.2 Office courtyard wall

As far as we are aware, this wall is not supported on a footing and is located on landfill.

To ensure stability, the wall will require to be rebuilt with a supporting footing founded in solid natural ground and in accordance with AS280-2011, *Residential Slabs & Footings*.

9.2.3 Portico column

The column doesn't require structural repairs. The gap in the soffit lining can be filled with architrave and then painted.

9.2.4 Bed 2 wall

The damaged bricks can be removed and replaced then re-rendered in accordance with the relevant requirements of the Building Code of Australia.

Other wall cracks can be repaired by grinding and cleaning and bonding with epoxy or cementitious grout and rendering.

9.2.5 Site maintenance

It is recommended that the site is managed in accordance with the CSIRO Foundation Maintenance & Footing Performance Guide, BTF 18.

10.0 INVESTIGATION & REPORT LIMITATIONS

This report is based upon our experience and opinions and is an assessment of the general circumstances observed at the time of inspection. Should conditions or damages vary after our inspection we are to be contacted in order that we may provide additional recommendations if required.

This is not an intensive/invasive investigation and as such our findings and reporting do not identify all damages and we are not responsible for identification of structural damages which cannot be seen or are inaccessible. Our investigation and reporting does not include indications of compliance with building codes or regulations. We are to be advised if any reported information is seen to be inaccurate.

We do not investigate for legal disputes nor do we correspond with legal representatives or provide expert witness testimony in legal disputes.

For all enquiries please contact this office.
0403 434 092, or admin@forensic-engineers.com.au

Yours faithfully

Mark Nicolson B.Sc. (Env Geo)
Geotechnical/Civil Engineering

Mr Ben Absalom
MIEAust CPEng NER
ENGINEERS AUSTRALIA | National Engineering Register
Signature _____ Date 4 / 5 / 2018
Registered on the NER in the area(s) of practice of Structural
RPEQ #17502

SITE PHOTOGRAPHS

01: The property

02: Driveway slab panel displacement

03: Driveway slab panel displacement

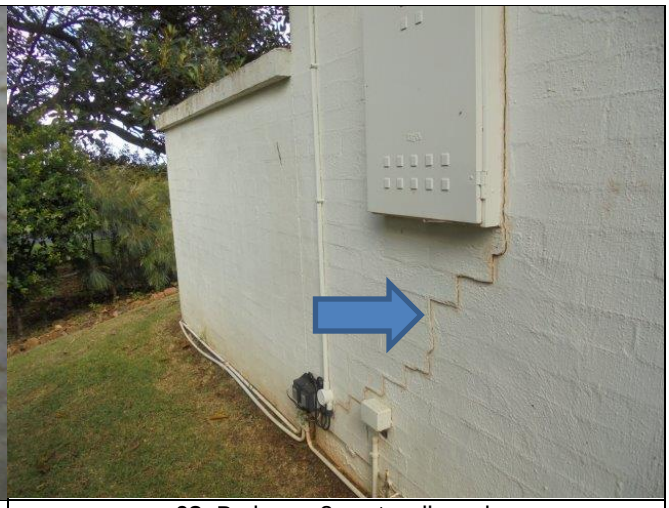
04: Office courtyard wall

05: Wall rotated out at the top and gap formed

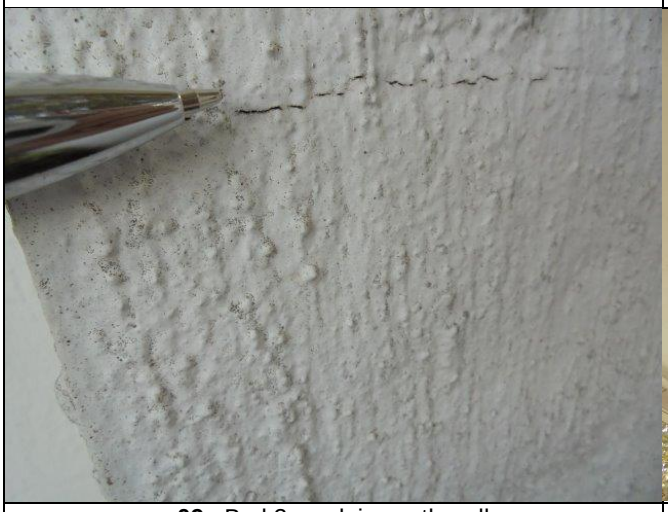
06: Office wall crack

SITE PHOTOGRAPHS

07: Bedroom 2 east wall crack. Note lateral displacement



08: Bedroom 2 east wall crack



09: Bed 2 crack in south wall

10: Portico column slight rotation and soffit gap

11: Portico column crack

12: Path at west side rotated outwards

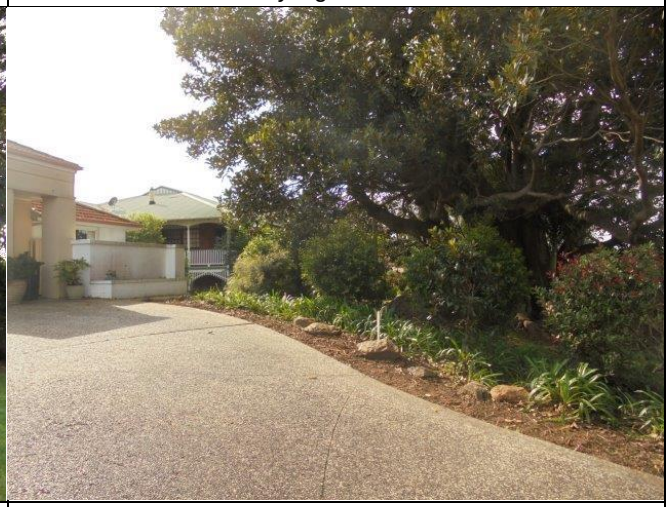
SITE PHOTOGRAPHS

13: Interior view

14: No damages to interior walls or ceilings

15: No damages to interior walls or ceilings

16: Floor levels show no evidence of heave or settlements of any significance



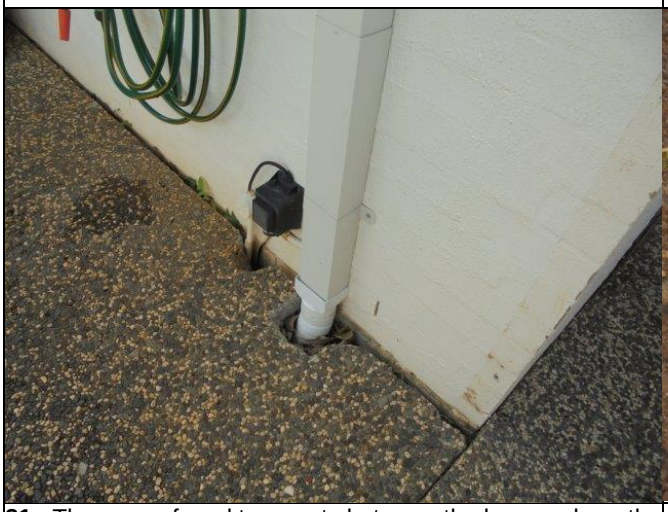
17: The fig tree

18: The fig tree

SITE PHOTOGRAPHS

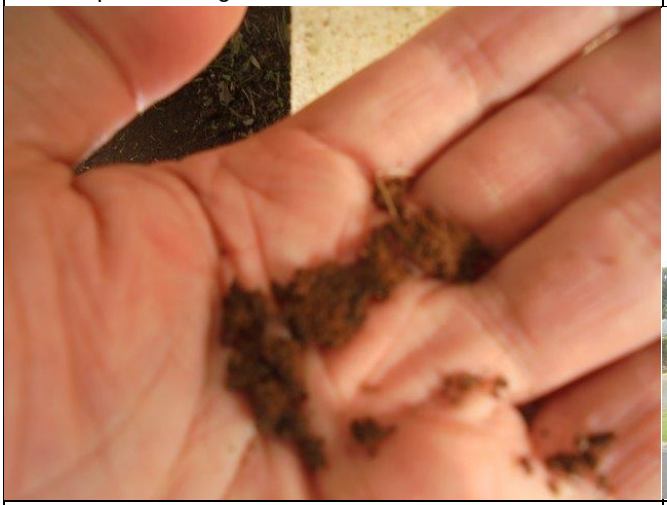
19: Tree roots running towards the house

20: Tree roots running towards the driveway

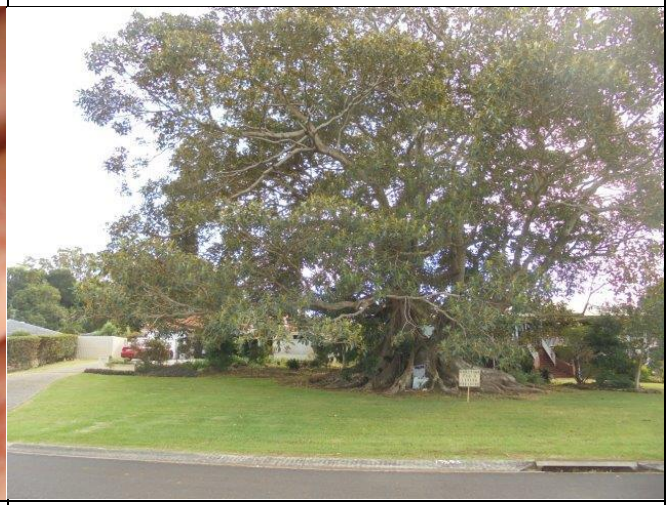


21: The owner found tree roots between the house where the path is lifting at the western side of the office

22: Fig tree roots at the east side of the bathroom



23: Surface soils are low plasticity silty clays (CL) with trace of sand



24: Overview from the street