Clay Lock
FOUNDATION STABILISATION SYSTEM

WHAT'S THE CLAY ISSUE?

DID YOU KNOW:

- **38% of 75,000 houses surveyed in a report by Archicentre have cracks**
- **Approximately $330 million is spent nationwide stiffening foundations per annum**
- **Despite this expediture, approximately 30% of Australian civil engineering insurance loss claims are for foundational damage**

THE ROOT CAUSE

- **Clay swells and contracts with the seasons**
- **Water penetrates layers of clay acting like a molecular jack**
- **Present foundation design methods are extremely sensitive to correct geotechnical assessment and either underperform or rapid cost escalation can result**

A SYSTEM EVEN HEAVY CLAYS CAN'T CRACK

The ClayLock System provides the best protection there is for structures on clay based soils.

ClayLock uses natural forces to bring about lasting soil stability for each construction, avoiding the need for complex and expensive footing strategies.

The technique involves extending the footprint of the structure to protect it from seasonal edge effects; and artificially raising the soil condition to its maximum moisture level beneath and around the slab during the first stages of construction.

The clay mound achieves its final state of moisture equilibration and stability under workable timeframes; with ongoing seasonal stability assured. Savings of up to $140 per square meter over foundational stiffening can be achieved on a standard low rise building.

The technique is patented and usable for modest royalties and usage provisions.

ClayLock is suitable for roads, rail, new 1—2 storey Housing or Unit Developments, Nursing Homes, Hospitals, Offices, Schools and most low rise constructions and Aquatic centres when constructed on Class S, M, H1 or H2 sites according to AS 2870 2011.

A Geotechnical report must be obtained to indicate whether clays are uniform or non-uniform. Special attention is required for mixed soil/rock combinations or some residual soil patterns derived from igneous rock.

ClayLock MUST be specified by an Airey Taylor Consulting Engineer.

Distance to the neighbouring boundary is a design consideration. Where control over total sub-development is available this is not a constraint.

On large scale installations of multiple or extensive structures, Airey Taylor Consulting requires involvement to ensure implementation conforms with the design intent.

"Due to spiralling costs, savings from the ClayLock system over conventional methods have significantly contributed to bringing the building to budget. Installation is simple and the builder reported no difficulties"

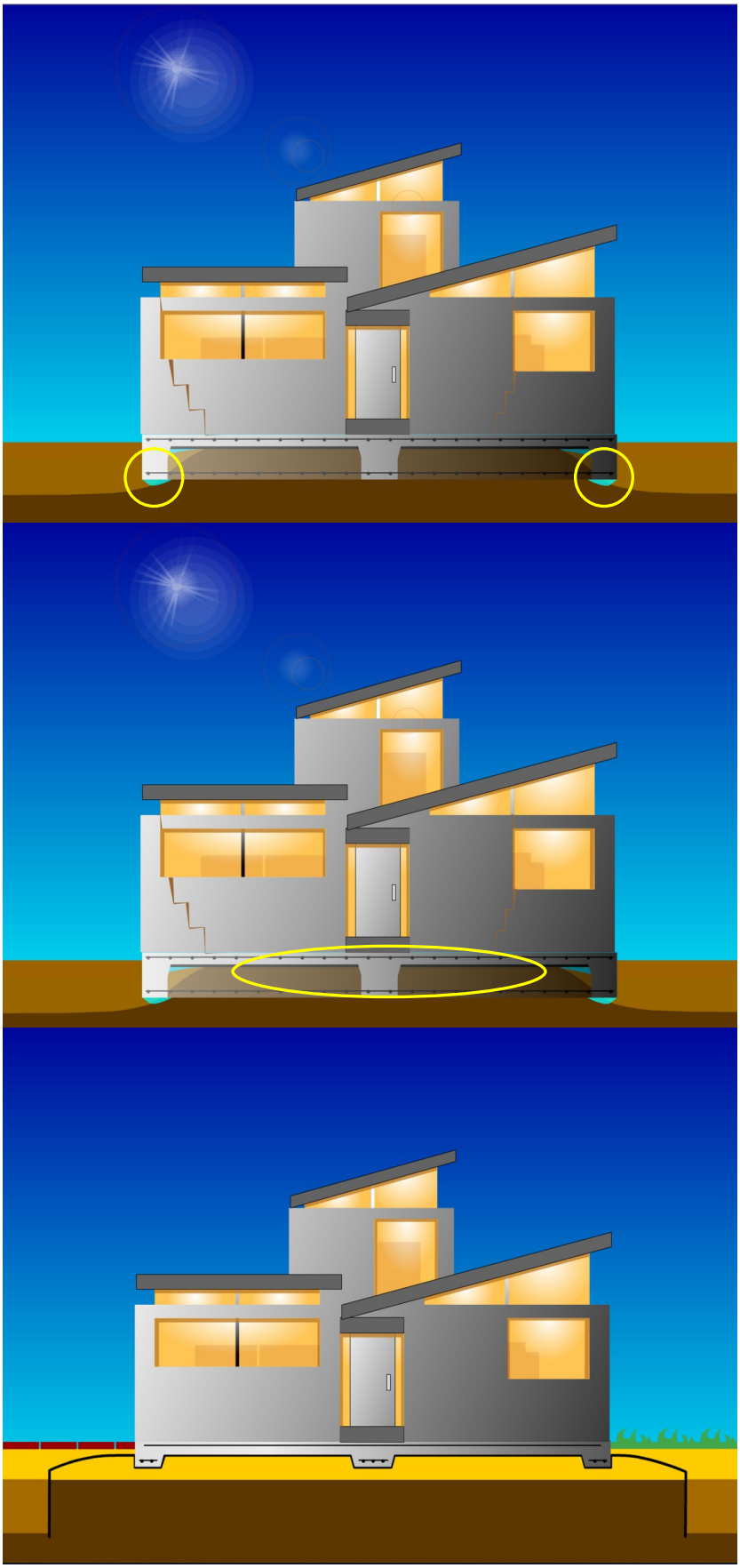
Peter Garvey
the Buchan Group Architects
Lumen Christi College Performing Arts Centre, Martin, WA
Builder: Derwent Constructions

DEFINING THE ISSUE

Clays undergo seasonal movement as they become wet and dry. In summer clays shrink, pulling away from foundations and potentially causing cracking. Movement of the clay that occurs in both early and later years is at the periphery (the circled corners at top right image) – the location of the structural walls on many buildings! The more reactive the clay the more extreme this is.

The central mound formed after many years of moisture equilibration is stable and referred to as "the dome". This forms because moisture is trapped beneath the polyethylene vapour barrier placed between the concrete to prevent rising damp stabilises the column of expanded clay beneath (seen on centre right).

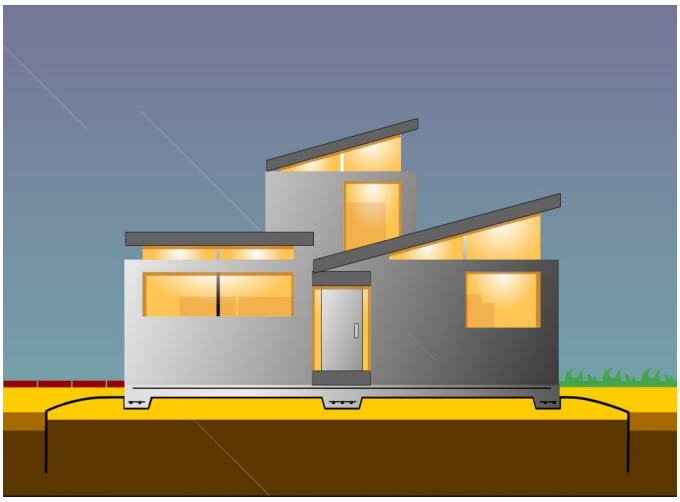
This has been documented since the 1970's.



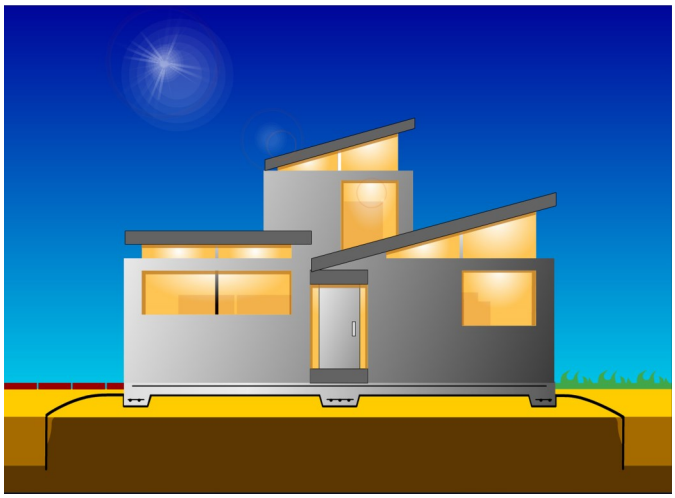
THE CLAYLOCK METHOD

- A membrane is used to mimic a larger building footprint so that the seasonal edge movement is kept well away from the structure (see below right)
- The formation of "the dome" underneath is accelerated by irrigating the encapsulated area during construction, so that — instead of over several years — the dome forms in approximately 3 to 5 weeks
- The building then sits on the stable expanded pad of clay before construction is completed. This uses the stability of the central clay mound to advantage.
- The irrigation does not have to be repeated so there is no ongoing requirement for water and the remediation is permanent
- The polyethylene membrane forms part of the foundations and must be protected during and after construction. A particularly durable form of polyethylene has been sourced by Airey Taylor Consulting for this purpose.

SEASONAL PERFORMANCE



In winter, the soils recharge with water around the structure – but the structure doesn't move as its sitting on its saturated pad already.



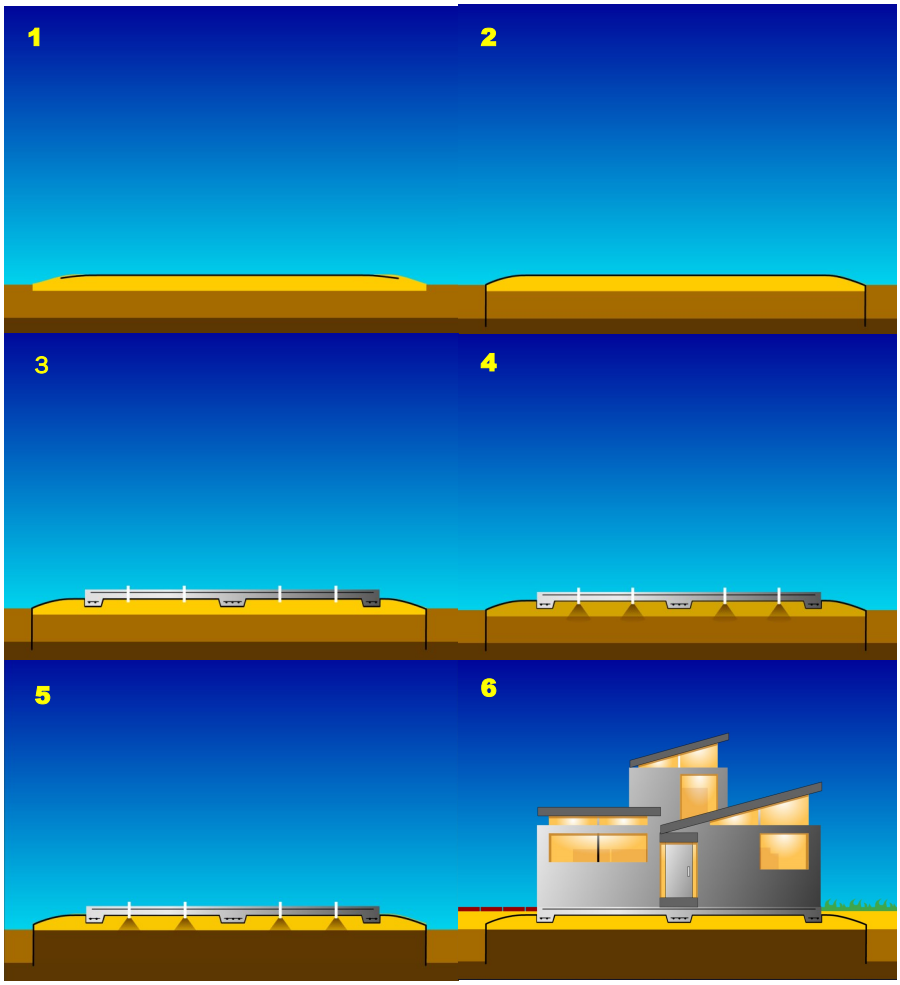
In summer the furthest edges from the building may dry out somewhat. This is catered for in the design.

CONSTRUCTION EXAMPLE FOR A LOW-RISE STRUCTURE

Note: Provision of this information does not comprise a waiver of patent rights nor should it be considered advice, or complete.

ClayLock is easy to install using usual trades:

1. An extended bed of sand is laid
2. A membrane is extended into a trench that acts to encapsulate moisture and prevent root ingress. Polyethylene and "root barrier" membranes are used.
3. The slab is cast including irrigation points
4. As soon as the slab is cast irrigation commences with water distributed evenly through the sand blanket beneath slab and footings (yellow area)
5. As the clay absorbs water into its molecular structure the pad of clay beneath the slab expands
6. Construction can continue during the "slab rise" period of approximately 3 to 5 weeks



2018 CASE STUDY FOR PRICE DIFFERENTIAL

SINGLE LEVEL ACCOMMODATION BUILDING
423.6 SQUARE METER FOOTPRINT
CLASS H1 SOILS, VICTORIA

Implementation of a Claylock® design was fully costed (including labour, design and royalties) and compared against a traditional method of foundation stiffening for Class H1 soils under AS2870 as part of a group of 59 buildings.

PIER DESIGN		CLAYLOCK®	
FOUNDATION	$23,175	FOUNDATION	$5,117
Excavation to perimeter ground beams, unreinforced piers (excavate and pour), soil disposal		100 cubic metres import fill, Excavation	
PLACEMENT :	$13,540*	PLACEMENT :	$22,970
Supply sand bedding, void former (supply and place), supply membrane protection for Piers, Labour to install sand and membrane		Supply sand bedding, supply membrane protection/root barrier for Claylock, Labour to install sand/membrane, backfill to trench, installation of irrigation/water injection points, labour to monitor water injection, survey slab prior and post-moisture conditioning for QA, Airey Taylor Consulting design and documentation, contract/engineering support, royalties	
REINFORCEMENT :	$39,670	REINFORCEMENT :	$10,225
Bars & Mesh		Post-tensioning, Other	
CONCRETE :	$54,571	CONCRETE :	$32,831
Slab 210 thick including waste, transition slab 125 thick including waste, edge beams GB01 including waste		Slab 150 thick including waste, transition slab 125 thick including waste	
TOTAL :	$131,136*	TOTAL :	$71,144
PER SQ. METRE :	$309.58*	PER SQ. METRE :	$167.95

***PLEASE NOTE**

The Pier Design figure does not include the costing for membrane (still required for the option) or the Design and Documentation cost of the existing design. The pricing differential will be even more pronounced with this included. The Claylock® option is completely detailed with all costs.

The unit cost may vary depending on location, scale and development and other factors—yet the differential is indicative of the clearly dramatic savings available using Claylock® as opposed to other traditional dounfation methods.

Irrigation points in place prior to slab pour at Merredin Residential College (left), and surface irrigation system outside slab (above)

PROJECT PORTFOLIO

DALWALLINU SHIRE OFFICES

Client: Shire of Dalwallinu
Architect: Guy Mander Architects
Builder: Geralton Building Co.

Dalwallinu is located 300 km North-East of Perth, WA. When the former council offices needed demolition after clay-related cracking, Geraldton Building Co. sought expert opinion on foundation design. The new Shire Offices were to be constructed on class"H" soils that become extremely desicated causing a local phenomenon known as "crabholes" (right) to open up as fissures beneath the soil cause local subsidences.

While durability was the aim, this original ClayLock design saved $68/m^2 (2000) compared to the original pile design. The building has remains undamaged by clay based movement since 2000. In such soils movement would become evident after 1 season.

The Shire provided testimonials and an invitation to participate in a series of staged developments of community buildings as regional funding became available.

LUMEN CHRISTI COLLEGE PERFORMING ARTS CENTRE

Lumen Christi College Performing Arts Centre, Martin (Perth)
Architect: The Buchan Group
Builder: Derwent Construction

The Centre incorporates a 348 seat auditorium & multi-purpose rehearsal/teaching rooms and access/foyer/exhibition spaces with extensive use of tilt-up panels.

Project approval was cost constrained, and ClayLock foundation technology enabled completion on time and budget.

The photo (near right) shows the approach to foundations was to lay all concrete foundations in one operation. The slabs were used as a base for preparing tile-up panels. Irrigation points were subsequently drilled in, whereas in other projects these points are cast-in.

MOORA HOSPITAL PHASE I & II

Client: Department of Health
Project Client: Department of Housing and Works
Architect: Bollig Design Group
Builders: Cooper and Oxley
Completed: Phase I February 2006; Phase II October 2016

Building crack issues from seasonal movement on clay soils are accentuated for hospitals owing to proliferation of germs on these surfaces, contributing to a decision to replace the original Moora Hospital in a "wheatbelt" town 2 hours north of Perth in Western Australia.

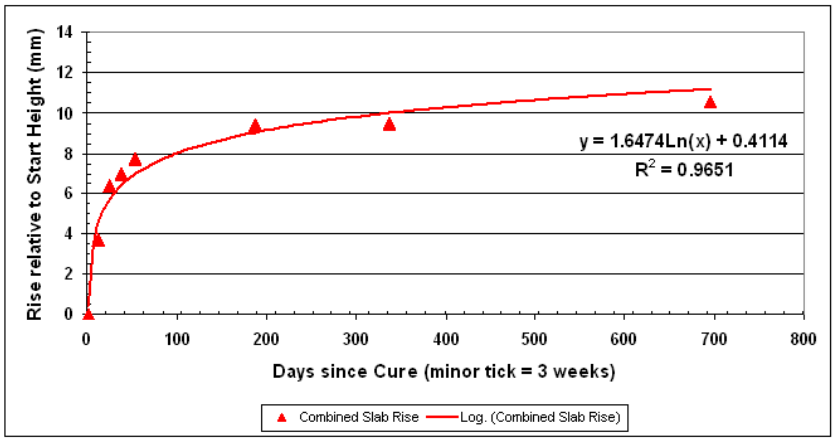
The project was constructed in two phases enabling continuation of the working hospital during construction, and is an example of side-by-side use of the ClayLock foundation technology.

Slab levels were monitored for two years (see graph below) showing after a (planned) initial rise as clays are plumped to stably expanded state within the first 8 weeks of the slab pour, followed by stability demonstrated over two full years at detection level of the survey 2 mm (normally oscillations on a type "H" soil can be up to 70 mm annually).

The courtyard photo (right) illustrates the architectural approach to protect the membrane by use of paving & verandah.

Tree management is an important part of the ClayLock design approach. A root barrier is incorporated and landscaping relegates trees to a distance.

Shrubs can be introduced right up to the building over the membrane.



1. *Construction on Stage 1 of the build shown (bottom left), with irrigation point clearly fixed at the time of the slab pour.*
2. *Stage 2 of the construction involved the creation of a "join" between the Claylock systems of both sites (top left).*
3. *The results of monitoring of the clay table over a period of two years demonstrates the stability achieved with the system (above)*

FURTHER WORKS

Claylock has successfully created enduring and stable foundations for a range of projects around Australia, including :

Schools : Merredin Primary School; Merredin Residential College; York District High School Performing Arts Building; Toodyay District High School Performing Arts Centre

Hospitals : Midland Nursing Home

Residences : Channybearup; 11 Chenin Lane, Ellenbrook;

Aquatic Facilities : Penrith Aquatic Centre; Kondinon Aquatic Centre; Northam Aquatic Centre

FREQUENTLY ASKED QUESTIONS

Q. What happens to termite control? Can irrigation points be an access route?

A. The holes are filled with a high-density filler. Termites cannot penetrate concrete.

Q. Does the method meet Australian Standards? Will it be approved at Council?

A. The method falls under the provisions of individual design by an expert provided by the Building Code of Australia. It has been registered with Australian Standards.

Q. Can anybody use it?

A. The method is Patent protected, which is the highest level of intellectual property protection, so users must seek permission to do so. Advanced Substructures has simple arrangements for one-off usage when we are the sub-structure designer. The royalty is paid as a line-item expense separate to the design fees.

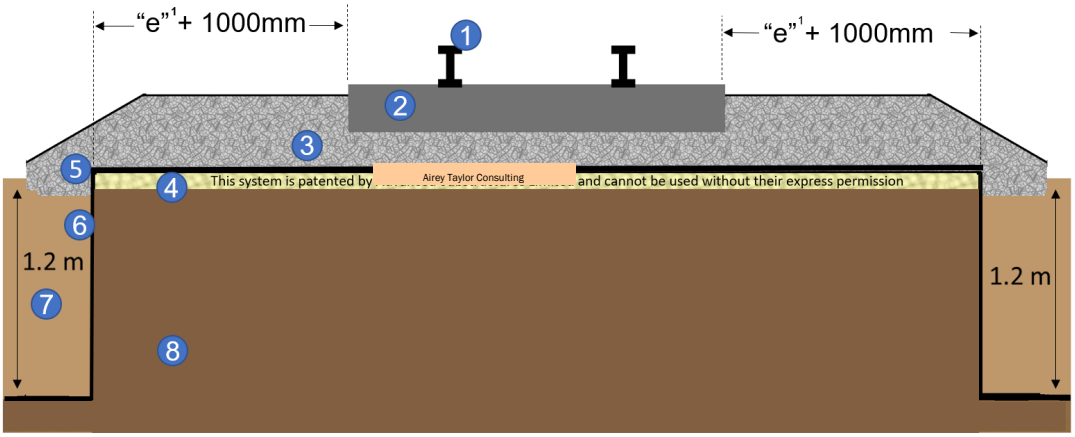
Q. What about risks of puncture to the polyethylene during construction or maintenance?

A. Airey Taylor Consulting has sourced an American polyethylene product which is extensively Quality Controlled and Assured, for use throughout Australia. While there is a slight price premium for the use of this product, it provides in the order of 50 times the durability of both puncture proofing and vapour permeability protection over regular polyethylene. It is highly recommended to use this product to mitigate any risks. We also require signposting completed constructions to contact Airey Taylor Consulting prior to commencing excavations at the site.

Q. Does it work for civil structures like road and rail?

A. Definitely. The same principles apply for the stability of all man-made structures built upon reactive soils. Below is an example diagram for rail that shows how Claylock® can permanently stablise rail on high plasticity soils.

1. Rail Line
2. Sleeper
3. Ballast
4. 150mm porous or compacted sand base
5. Stego® or approved equivalent polyethylene layer
6. Root barrier
7. Backfill with natural soil
8. Moisture conditioned clay mound



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