

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 expenditure, 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 low rise or civil developments 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 accelerating 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. In addition, savings of \$42-95 per square meter over foundational stiffening are achieved.

The technique is patented and usable for modest royalties (\$4 per square meter of ground floor coverage) and usage provisions.

ClayLock is suitable for roads, rail, new 1-2 storey Housing and Unit Developments, Nursing Homes, Hospitals, Council offices, Schools and most low

rise constructions and swimming centres when constructed on Class S, M or H sites according to AS 2870.

A Geotechnical report must be obtained to indicate whether clays are uniform or non-uniform. Any soil type (S, M or H) is acceptable providing the block is uniform. ClayLock is NOT suitable for mixed soil/rock combinations or some residual soil patterns derived from igneous rock.

ClayLock MUST be specified by an Advanced Substructures Engineer.

A limiting factor in building development in constructed suburbs can be distance to the neighbouring boundary. Where control over total sub-development is available (e.g. at Juniper Gardens (A \$20 million combined residential/commercial project) this is not a constraint.

"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

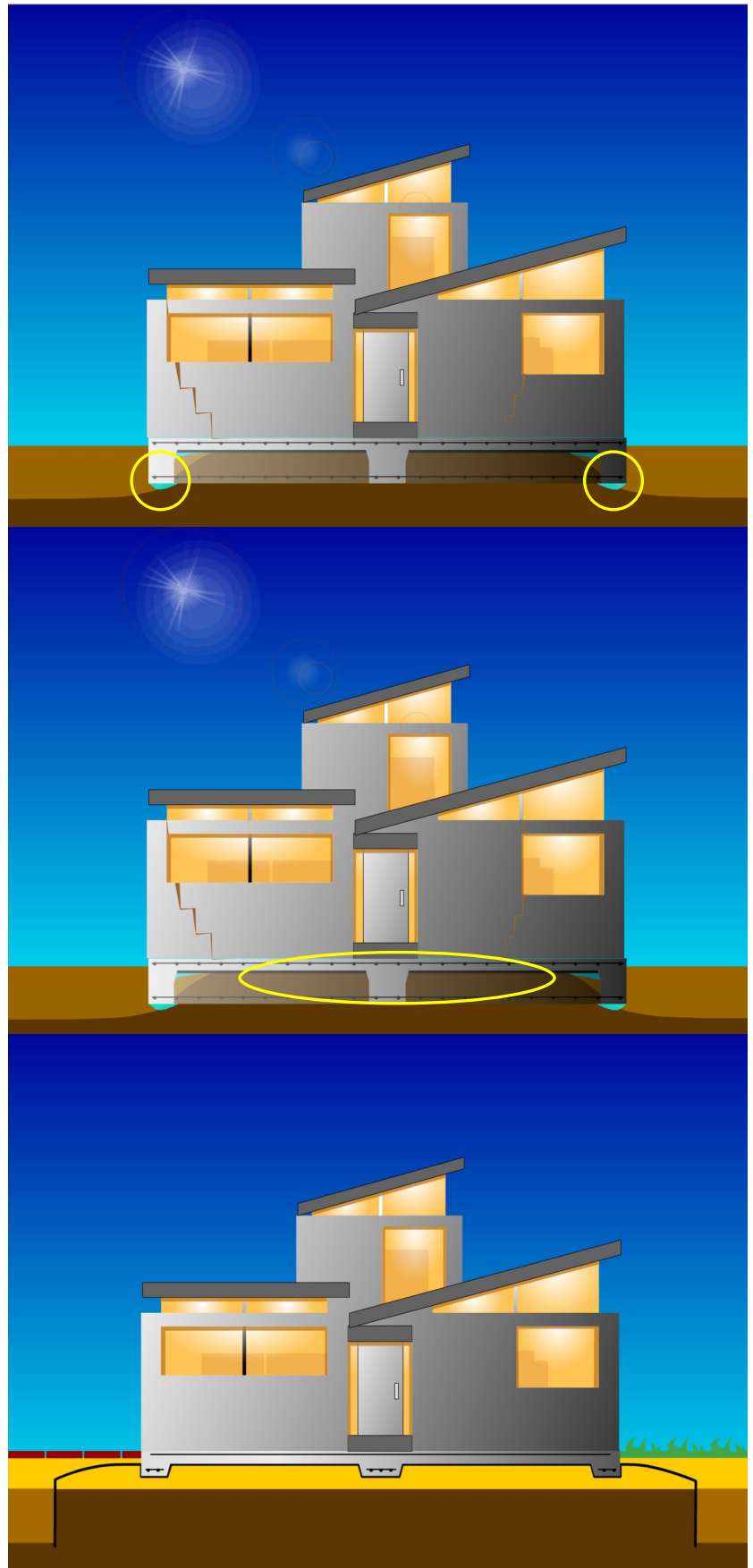
Clays undergo seasonal movement as they become wet and dry. In summer clays shrink, pulling away from foundations and potentially causing cracking. Movement of the clay that occurs in both early and later years is at the building periphery (the circled corners at top right image) – the location of the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

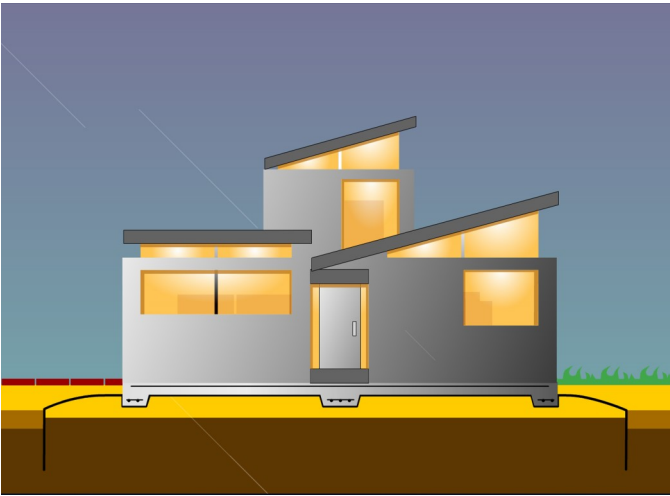
These facts have been well documented since the 1970's.

THE CLAYLOCK METHOD

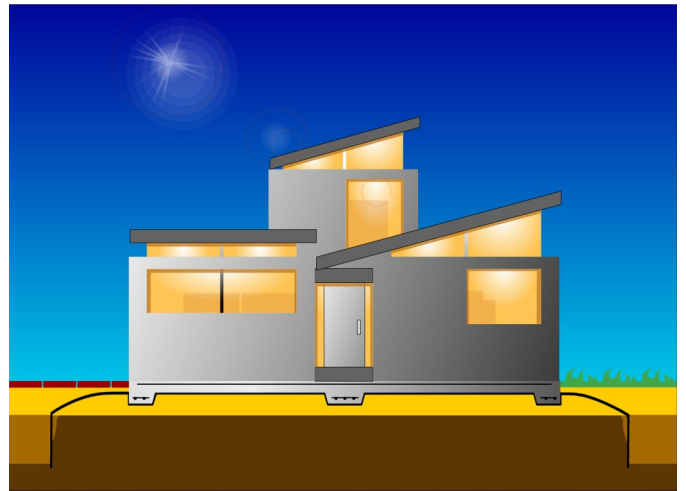
- A membrane is used to mimic a larger building footprint so that the seasonal edge movement is kept well away from the structure (see right, below)
- The formation of “the dome” underneath is accelerated by irrigating the encapsulated area during construction, so that instead of over several years the 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 Advanced Substructures for this purpose.



SEASONAL PERFORMANCE



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



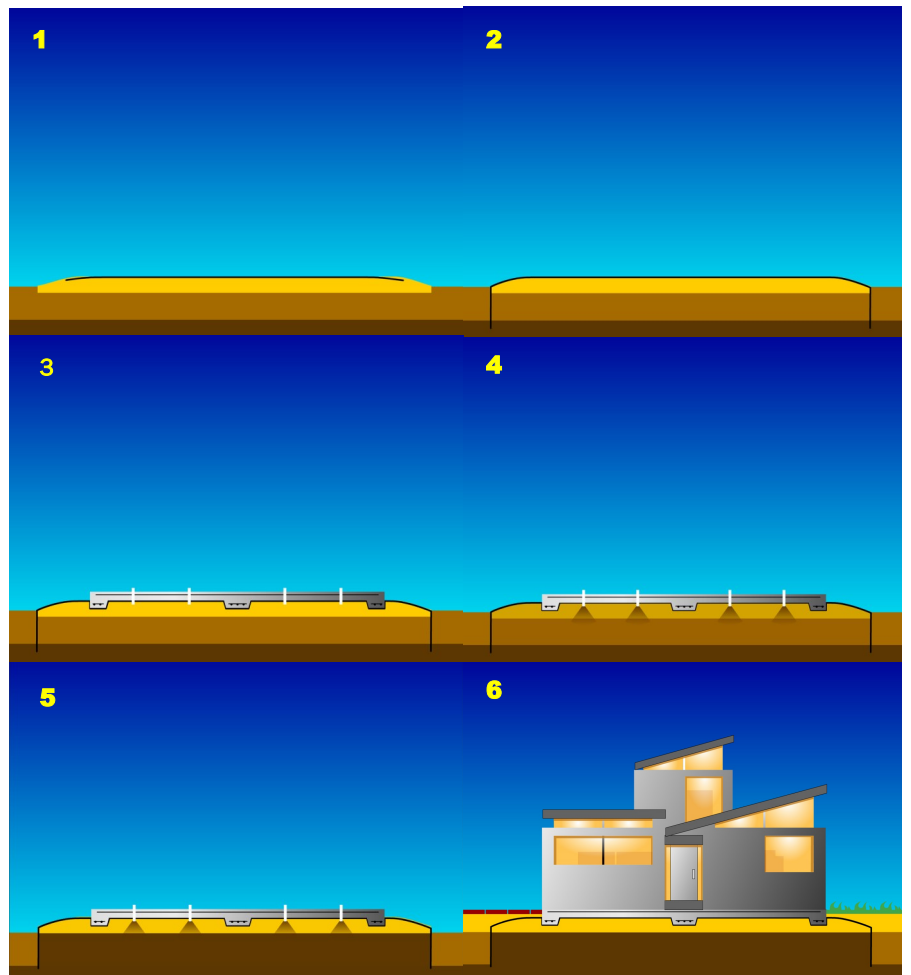
In summer the furthest edges from the building may dry out somewhat. This is catered for in the design.

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



PROJECT PORTFOLIO

DALWALLINU SHIRE OFFICES

Client: Shire of Dalwallinu
Architect: Guy Mander Architects
Builder: Geraldton 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 des-

sicated 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/m² (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 tilt-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.

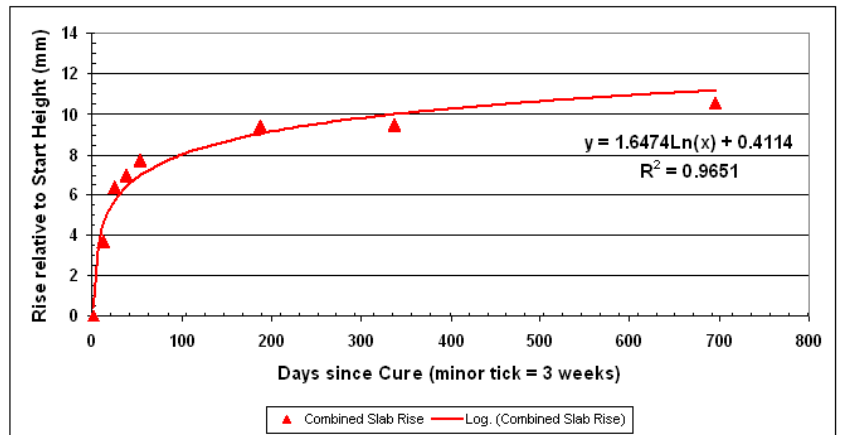
Slab levels were monitored for two years (see graph below) showing after a (planned) initial rise as clays are plumped to stably expanded state within the first 8 weeks of the slab pour, followed by stability demonstrated over two full years at detection level of the survey 2 mm (normally oscillations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

GUILDFORD PRIMARY SCHOOL LIBRARY

Client: Department of Housing and Works
Architect: Bollig Design Group
Builder: Cooper and Oxley
Sub-Contractor: Hoskins & Ioannopoulos

The builder approached experienced sub-contractor Hoskins Iannopolous & Sons Pty Ltd to install irrigation points in slabs and points external to slab.

Slab level monitoring by the Engineer indicated the "slab rise" minimal as expected on already saturated soils next to the Swan river.

Right: Irrigation points dotted through main slab.



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



Contractor assembles irrigation system to supply up-hill side of sand blanket.



Surface irrigation system outside slab.



Irrigation points in place prior to slab pour at Merredin Residential College



Library nears completion.

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 design fees.

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

A. Advanced Substructures 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 Advanced Substructures prior to commencing excavations at the site.

Q. Do you have more recent examples?

A. Advanced Substructures has obtained the patent for Claylock in 2018, and is engaged in more recent projects across Australia. We will be showcasing these projects as they are completed.

COMPARISON OF IMPLEMENTATION COSTS

Independently evaluated by Ralph & Beattie Bosworth Quantity Surveyors (2008)

Property	ClayLock Design (\$/m ²)	Stiffened Raft (\$/m ²)	Cost Saving (\$/m ²)	Cost saving (%)
Aged Persons Units -Bassendean	207.08	258.24*	51.69	20
Hospital-Rural	148.22	248.47+*	100.15	40
Aged Persons Units -Gosnells	194.50	302.40+*	107.90	36

* implemented in practice; + cracked structure brought to ATC's attention.

ABOUT US

We are an **Engineer led team** with over 45 years experience in our specialist fields from challenging projects world-wide

We provide **cutting edge design of substructures** both above and below water levels

We provide **problem solving** tailored to each individual site. As no two sites are the same - no two solutions are the same

We make projects **viable and profitable** to construct through :

- Increasing site footprint and usable space
- Reducing construction time
- Reducing capital cost
- Reducing construction risk
- Reducing project holding costs
- Reducing materials use and costs
- Reducing risks to surrounding buildings and environment
- Reducing risks of water ingress or cracking

WE

Deliver innovative designs that are substantially quicker and cheaper to build, with minimal impact on neighbours and other environmental stakeholders

Create for purposes ranging from underground roadways and tunnels to a plethora of commercial, civic, residential and other applications

Construct foundations and sub-structures that are stronger; more spacious and elegant; more durable and watertight

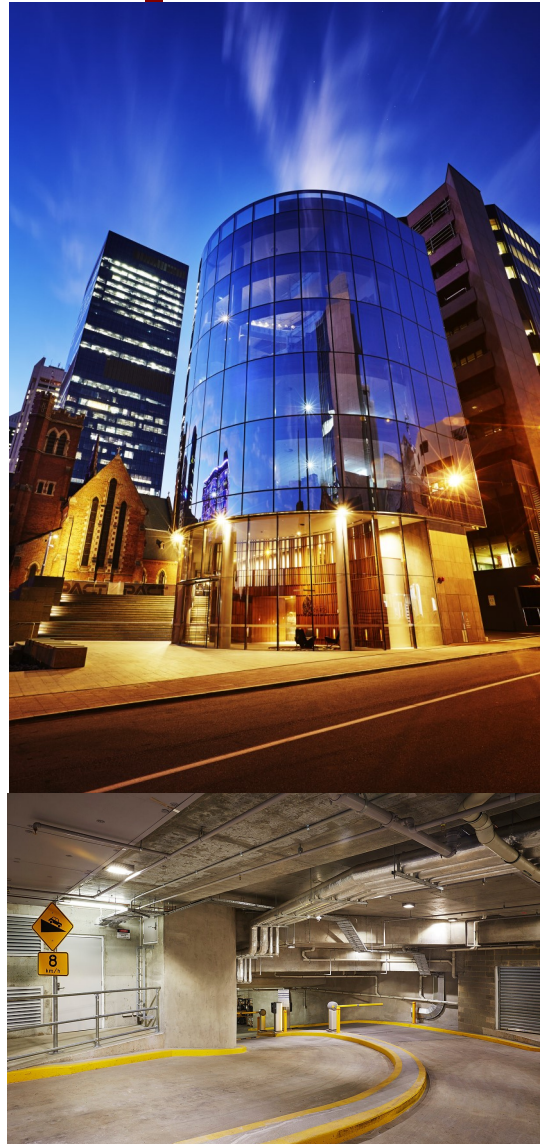
Remove basement excavation from the critical path, increasing working fronts in construction and increasing overall project speed

Utilise a comprehensive suite of answers for building on clay, that improve upon the AS2870 (Residential Slabs and Footings) code

Operate from a proven track record of safety and creative innovation for the best possible foundations and basements

Conduct groundbreaking research in many areas producing existing and forthcoming innovations and patents resulting in cost cutting and other improvements

Achieve significant capital and other cost savings to the full satisfaction of our clients



2017 Master Builders Association (Australia) Excellence in Construction Award winner for Best Commercial/Industrial Building \$20-50 M showcases the talent of Advanced Substructures



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