Excavation along the Atlantic Seaboard, Cape Town – Part 3: Future

The following article is the third in a three-part series that reviews the historical, current and future practice of excavation along the Atlantic Seaboard in Cape Town and is the full version of an abridged paper that will be presented at the 2nd Southern African Geotechnical Conference in Umhlanga from 28 to 30 May 2025. The first two articles were published in the **March 2025** (Vol.33, No.2) and **April 2025** (Vol.33, No.3) issues of *Civil Engineering*.

Frans van der Merwe Pr Eng
Senior Design Engineer
Franki Africa
frans.vandermerwe@franki.co.za

Mike van Wieringen Pr Eng, Pr SciNat
Founder
M. van Wieringen & Associates
mwgeo@iafrica.com

Nicol Chang Pr Eng
Technical Director
Franki Africa
nicol.chang@franki.co.za

Figure 1 Known properties in Clifton with lateral support, totalling more than 50

NEED FOR ACCURATE RECORD KEEPING

As part of a recent exercise, information was collected by the City of Cape Town regarding the presence of anchors and geonails in Bantry Bay and Clifton. Figure 1 shows locations, in Clifton above 1st, 2nd and Moses Beach, where lateral support systems are known to be present. Fewer lateral support systems are present above the 3rd and 4th beach, which is part of the bungalow heritage area. As can be seen, the number of sites is significant and highlights the need to keep accurate records and ensure that future developments investigate the presence of such anchors, especially where these exist in public land, such as beneath roads.

GUIDANCE ON GRANTING PERMISSIONS

For property owners, requests to install either permanent or temporary anchors below their properties are often met with hesitation, as they seek to preserve their future rights and development options. Permission agreements to install grouted

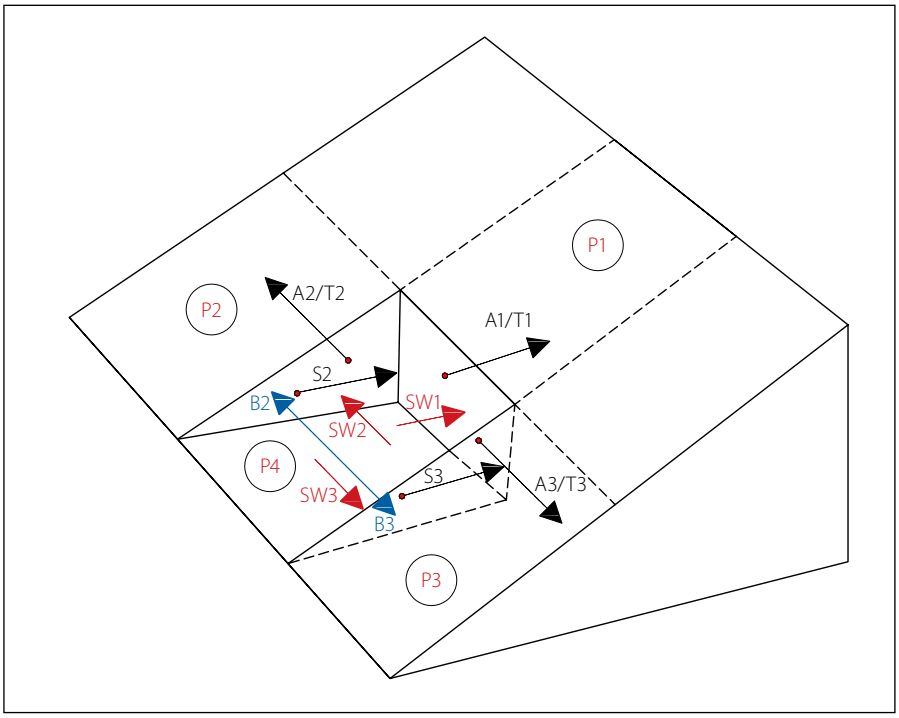

Figure 2 Properties (P1, P2, and P3) adjacent to and excavation on property P4, showing various components that could provide lateral support

anchors or geonails into neighbouring properties are particularly difficult to negotiate, even when this option would be the best choice to safeguard neighbouring properties from potential movements and collapse risks. Several factors contribute to this, including:

1. The review of requests without unbiased professional advice (requiring neighbours to hire their own geotechnical engineer out of a very small pool of geotechnical engineers with lateral support design experience).
2. Fear that grouted anchors could damage the property, infringe upon future rights, or limit future development options in terms of excavation, piling, anchors, foundations, etc.
3. The perceived liability associated with granting permission.
4. Neighbours being intentionally obstructive due to overruled objections over building plans or anticipated depreciation in property value.
5. The legalities and cost surrounding registering temporary or permanent sub-surface servitudes to accommodate such anchors.
6. The reluctance of developers to provide adequate guarantees against damage that might occur as a result of the installation.

When permission cannot be obtained, alternative methods may be explored by the developing property owner, such as temporary internal propping using steel or concrete elements, top-down construction, cantilevered systems, or unsupported cuts. While the last option exposes the neighbouring property to significant risk, the other methods can on occasion induce more movement than would typically occur with the use of grouted anchors.

Permission agreements to install permanent anchorage are nearly impossible to obtain, as a notarial deed of servitude must be lodged against the neighbouring property to ensure the anchorage is recognised in perpetuity. Changes to a title deed are often met with hesitation, as they are believed to potentially affect property value and resale prospects. If a neighbour agrees to allow the installation of temporary or permanent anchors, they

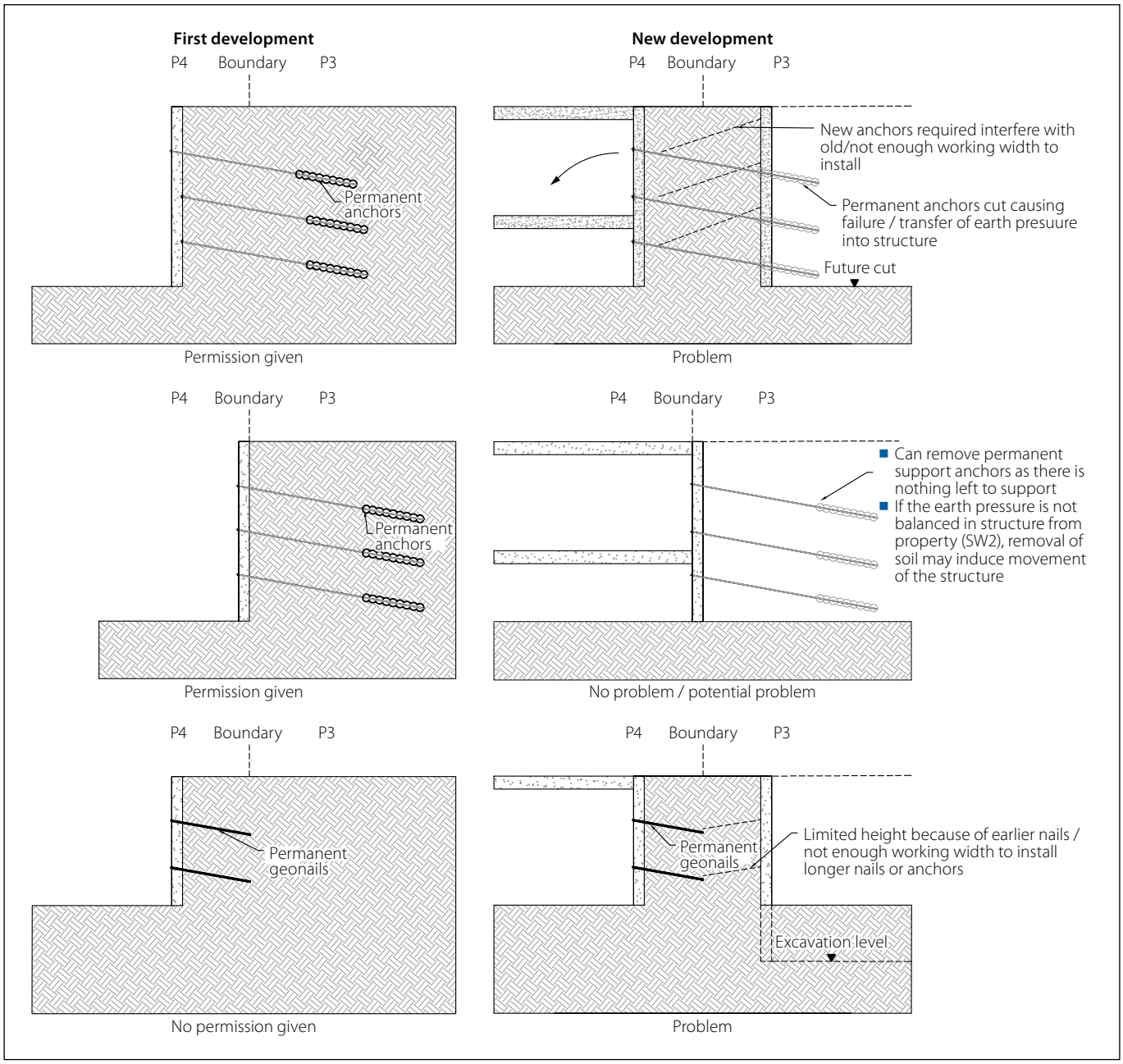

Figure 3 Examples of potential future cut scenarios during excavation on P3: (top) lateral support facing P4 with permanent anchors not on boundary, (middle) lateral support facing P4 on boundary, (bottom) no permission obtained by P4 to install T3 or A3 into P3

Figure 4 Area of the Atlantic Seaboard under consideration

should be granted some negotiating power concerning future development on their property.

Consider four adjacent properties (P1 to P4), shown in Figure 2, with excavation on P4 up to its boundaries.

Lateral support to faces 1, 2 and 3 can be provided by shear resistance along sides 2 and 3 (S2, S3), permanent anchors A1, A2, A3, temporary anchors T1, T2, T3, internal slabs and shear walls SW1, SW2 and SW3, or bracing and balancing across B2-B3. Cutting to stable slopes does not require permission but can result in large movements. Similarly, internal buttressing of sides down to the floor does not require permission, but space requirements usually preclude this. Note also that B2 requires the pressure of B3 and that S2 and S3 are both required for balance. As an example, there would be potential damage to the structure on property 4 in Figure 2 when either property 2 or 3 decides to excavate, if reliance was placed on earth pressure balancing (B2-B3) between cut faces 2 and 3 or S2 or S3 during property 4's construction.

In terms of the neighbours wishing to excavate up to the boundary in the future, it would imply the removal of B2 and/or B3, S2 and/or S3, A2 and/or A3 for properties 2 and 3 and A1 for property 1. In the generally steep and highly valued terrain of the Atlantic Seaboard, development inevitably implies excavation, and it is clearly not in a neighbour's interest to forego lateral support. This then leaves the neighbour (P2 and P3), if they wish to prevent future issues when they want to remove B2 or B3, S2 or S3, from providing lateral support to P1 and P4, of temporary anchors T1 to T3 and permanent anchors A1 to A3. If only temporary anchors are permitted, the structure on P4 will need to brace excavation faces 2 and 3 by incorporating shear walls, as removal of B2 or B3 would result in an unbalanced earth pressure distribution acting in the structure.

All of the above is usually further complicated by excavations not being taken to the boundary. This leaves a slither of land between properties that future excavation on the neighbouring property is required to support. Some examples are provided in Figure 3. For example, permanent anchors on the boundary can be removed if there is nothing left to support, which is advantageous to P3 if shear walls are also incorporated in the structure on P4 to withstand earth pressure from one side only if P2 did not also allow permanent anchorage.

The bottom line is that developers, geotechnical design engineers, neighbours and lawyers should consider all possible permeations of future development before committing to any designs or agreements.

If permanent anchorages are permitted, a notary deed of servitude must be lodged in perpetuity on the neighbouring property to prevent any future damage to the permanent anchors. This is important because, while the scenarios described above apply if the neighbour plans to excavate to the same level, a neighbour constructing a new structure with piled foundations at a higher level could damage the permanent anchors.

As part of any anchorage agreement, it is also advisable that the owner undertaking the excavation takes out removal-of-support insurance. In some cases, a secure bank guarantee is requested by the neighbouring properties to ensure protection against potential damage.

LOOKING AT PAST FAILURES TO UNDERSTAND THE FUTURE

On 11 June 1905, a significant debris flow occurred in the ravine just above Clifton House (Site 2 in Figure 4), taking part of the original structure with it (De Beer, 1987). This event was triggered by a heavy downpour and a recent fire on the slopes of Lion's Head, which left the soil bare of vegetation. A water main located just above the ravine was damaged when struck by the debris.

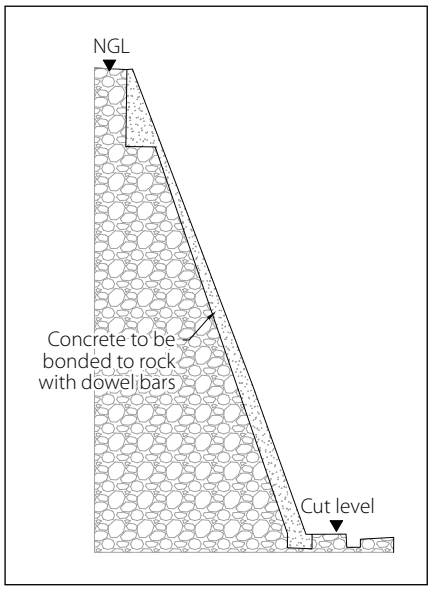

Figure 5 Typical concrete retaining structure/erosion protection used for earlier cut faces

Another failure took place on 26 August 1933, on an unsupported cut face above Victoria Road at 29-35 Victoria Road (opposite Site 3 in Figure 4). A block of decomposed granite fell from the cut, leaving a house precariously close to a 10 m high precipice – a cut made by Thomas Bain 46 years earlier. A reinforced concrete wall was constructed to support the house. A section through a typical wall used to stabilise the road cuts during that period is provided in Figure 5.

Three years later, on the same day, 26 August 1936, a slope failure endangered the Montreux double-storey house, causing their garden to crash 30 m into the sea below. This left only 0.6 m between the house and a dangerous drop to the rocks below.

In 1999, during the excavation for Dunmore Apartments, the neighbouring balcony collapsed into the excavation pit. The structural damage led to the eventual demolition of the house.

In 2012, a wedge failure occurred in the cut face below 13 Victoria Road, further highlighting the ongoing risk in this area.

On 10 July 2020, a large slope failure occurred above Kloof Road, below 2 Nettleton Road (see Figure 6), and on 24 September 2023, another slip failure took place below Kloof Road, very close to the Round House (Site 1 in Figure 4).

These unsupported cut failures will increase in occurrence due to increased weathering of exposed material, global warming and change in weather patterns, channelling of water, plant growth on rock faces, and associated opening of rock joints and increased shade.

2D VERSUS 3D ANALYSIS

In most scenarios, lateral support systems are designed using 2D analyses. As discussed in **part 2**, 2D finite element (FE) analyses typically predict larger displacements compared to 3D FE analyses, as the latter accounts for the enhanced resistance to slope failure from the sides of a slip surface. Additionally, in some cases, if the soil is able to arch between the two lateral support faces, the pressure could be further reduced, as the failure mechanism would resemble that of a semi-silo (Perko, 2008). However, if a neighbouring property is excavated, the soil may no longer be able to arch, leading to an increase in pressure from the face (Conventional Slope Failure in Figure 7).

If the structure is used to prop (SW1) cut face 1 (refer to Figure 1 and 8), additional displacement would occur at the corner between the previous cut faces 1 and 3, due to the removal of the stabilising soil mass (P3-corner effect), should excavation take place on site 3. This will lead to addition pressure being attracted to the slabs and torsional loads developing in the concrete frame.

The need for complex modelling will increase due to the interaction between lateral support systems on neighbouring properties as well as the intricate interaction of the infill structures with lateral support systems. However, data from adjacent sites (ground investigation and implemented solutions) would be

Figure 6 Recent slope failure on Kloof Road (Clifton)

lacking as they are not stored on a central database. If no information about adjacent sites is available, it is advisable to inspect the neighbouring property to determine whether any lateral support systems are in place, to establish its permanency if present, and to assess how the structure interacts with lateral support or earth pressure from cut faces.

CREEP OF NATURAL SLOPES

In many instances, natural hill slopes or unsupported cut slopes exist above lateral support systems. Over time, these slopes may gradually creep downwards, increasing the earth pressure experienced on the top of the lateral support system. The depth of the creeping zone is challenging to assess, and inclinometer installations are typically required to determine its extent. Strategies for managing this additional pressure are thoroughly discussed by authors such as Brandl (1979). It must also be noted that discussion has been limited to dealing with lateral support in cut slopes and that compacted backfill behind retaining structures can result in horizontal pressures well in excess of even the passive case.

Structural damage or failure from such creep is noticeable in buildings and retaining structures across the Cape Peninsula. The effect of such creep and damage often only becomes noticeable after some time. This could, therefore, result in damage to older structures with crest slopes above lateral support systems which are in contact with the structure.

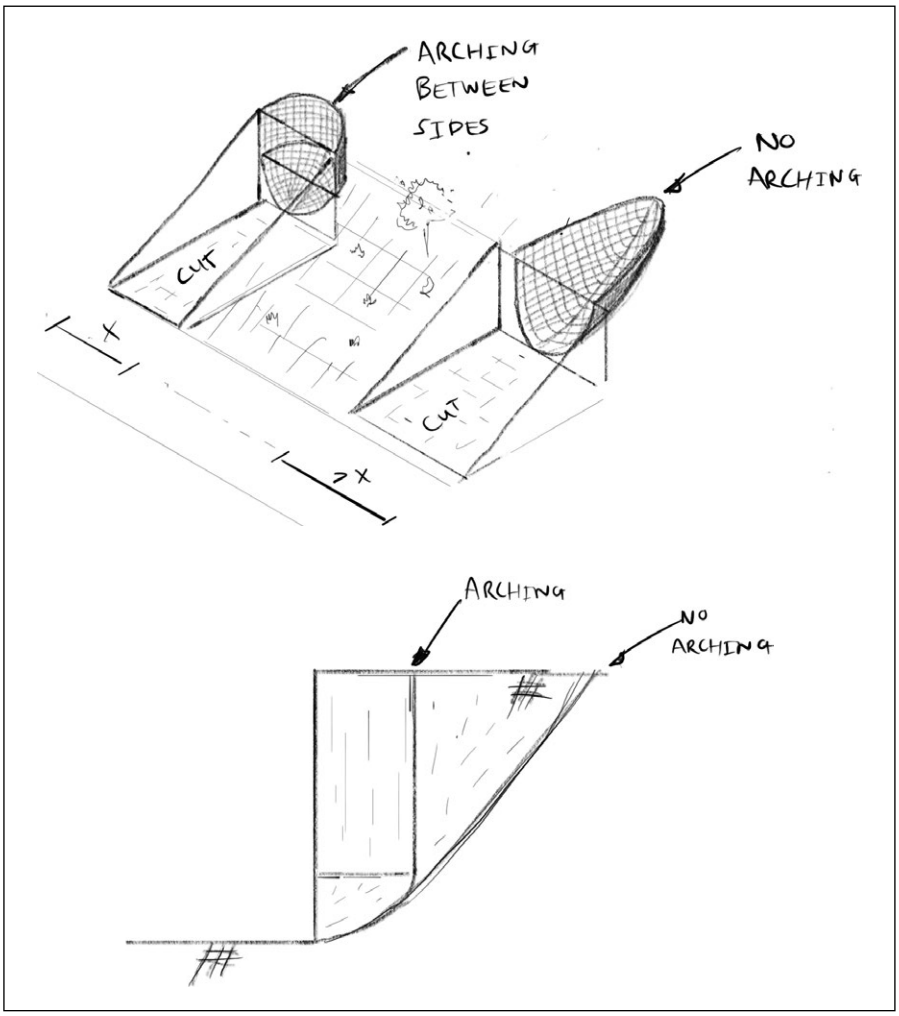

Figure 7 Left arching between excavation walls (semi-silo) versus right conventional slope stability problem

FUTURE OF LATERAL SUPPORT ON THE ATLANTIC SEABOARD

Heritage and environmental objections

In 1948, the area below Victoria Road, extending from Fourth Beach to Glen Beach, was designated as a national monument. Several other areas along the Atlantic seaboard have also been recognised as provincial heritage sites or are protected by the City's zoning schemes. These regions are considered cultural landscapes, shaped by the long-standing interaction between human activity and natural systems.

Notable areas within this classification are the bungalow heritage areas (light pink in Figure 9), where strict building guidelines ensure that the dense vegetation, natural environment, and bungalows blend seamlessly with the surrounding landscape. Here, excavations near property boundaries are prohibited to protect trees and vegetation, as excavation could lower the phreatic surface or damage the roots of established plants. These properties tend to be small, with height restrictions in place to prevent the development of large apartment blocks. Table Mountain National Park and the

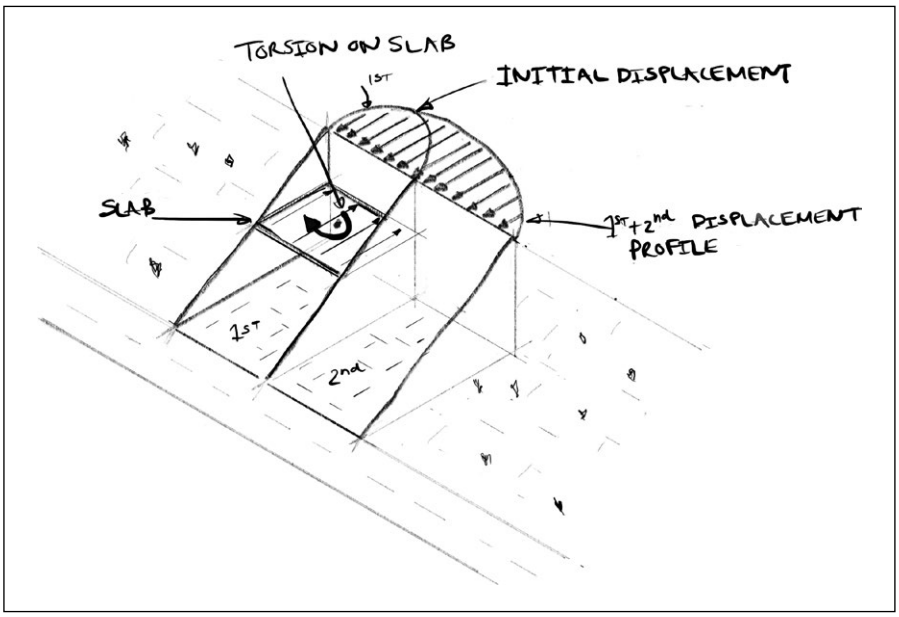

Figure 8 Additional pressure attracted to concrete structure during excavation on neighbouring site

Figure 9 Heritage zones between Clifton and Camps Bay (City of Cape Town Citymap viewer)

Maiden's Cove heritage area (Site 13 in Figure 4) also fall within this region (represented by the dark pink zones in Figure 9).

Several properties below Kloof Road are zoned as public open space (POS). While the City of Cape Town (CCT) may sell these properties, such sales are often met with opposition or require extensive public consultation. For example, the Maiden's Cove Action committee and the Bungalow Owners' Association challenged the proposed sale and redevelopment of Maiden's Cove by private developers in court. Furthermore, any rezoning of POS to commercial or residential use cannot proceed without impact studies.

Concerns have been raised that these developments would strain the sewer systems and exacerbate traffic congestion in an already heavily trafficked area, while CCT argues that such redevelopment would improve beach accessibility and provide an economic boost to the region.

In addition to heritage considerations, zoning laws and environmental requirements need to be assessed in accordance with the National Environmental Management Act (107 of 1998). A basic assessment is required if more than 5 m^3 of material is excavated or deposited within 100 m inland of the high water mark. Future deep excavations are therefore anticipated to primarily occur in Greenpoint, Seapoint, Bantry Bay, Fresnaye, Clifton above 1st and 2nd Beaches, Camps Bay, Bali Cove, and parts of Bakoven.

As anchors into neighbouring properties are becoming less acceptable, self-supporting structures will have to become the norm, and amalgamation of erven will be required to create bigger footprints to accommodate buttresses and shear walls.

Land use objections

Building plan approvals are governed by CCT's Municipal Planning By-law (2015), which requires all developments to be publicly advertised. Any objections must be submitted to the council, supported by relevant legal and technical arguments. The city then makes a decision on the application. If the objector is dissatisfied with the decision, they can file an appeal. In these areas, the affluent homeowners often only liaise through their legal advisors, and appeals are therefore frequently contested in court, which extends the approval process, often making development slow and challenging.

Objections and appeals are common along the Atlantic Seaboard, where both the community and property owners often recognise new developments as threats to the area's charm, history, exclusivity, and services, and as having the potential to lower property values. These objections will increase in future.

Ground movement assessment (GMA) report

GMA and basement impact assessments are becoming increasingly popular in other parts of the world, especially London where these assessments are typically required by the borough (local government) to prevent damage to buildings and services. It is foreseen that these assessments should become more commonplace by local government should their services or roads be involved, or by neighbouring properties in granting permission.

Earthquakes

Earthquakes are seldom taken into account, both in the past and at present. A big earthquake could be disastrous for the area, particularly for retaining walls, such as segmental block and gabion walls, or buildings propped up against lateral support systems.

What happens when anchors reach their design life?

Ground anchors are highly susceptible to corrosion, particularly the anchor head and the zone immediately behind the head, in coastal areas with an ISO 9223 C4 corrosivity category. The aggressive nature of the groundwater, with a pH of around 5.0 to 5.5 and low total dissolved carbon content, exacerbates the corrosion risk. This makes it essential to implement a thorough inspection and maintenance plan throughout the lifespan of the anchors to ensure their proper function. This plan should involve regular inspections (frequent at first and then every five years) and lift-off tests to detect any signs of creep or corrosion.

Permanent anchors typically have a lifespan of up to 100 years, while a building's design life is usually around 50 years. This, however, does not mean that the property owner must or wants to demolish the building when it reaches a life of 50 years. The owner would generally prefer to undertake extensive maintenance work and extend the building's life or leave it to dilapidate further until funds are available for maintenance.

If inspections reveal that anchors have exceeded their design life or show signs of damage, repairs or replacements may be necessary. In some cases, this could involve replacing anchor heads or fully replacing anchors, which may require the building's occupants to temporarily relocate and having to refit a damaged interior after demobilisation of destructive drilling equipment. Alternatively, if the anchors are beyond repair, the entire building may need to be demolished and replaced. However, such a decision is complex, especially in sectional title schemes where coordination with multiple stakeholders is required.

It is unlikely that all ground anchors will fail simultaneously or in a brittle manner. In most cases, failure would likely manifest as cracking in the structure or road above, providing early warning signs before a catastrophic collapse occurs. This would ideally prompt an investigation and remediation process. However, this could be a costly and disruptive exercise. If left unaddressed, a collapse could eventually happen.

Furthermore, council should serve a notice that an intervention is required if it affects public safety and, if not addressed,

could result in civil action or a criminal offense.

A key challenge with ground anchors is that they are often not easily accessible, as they are typically concealed by a surficial brick skin or integrated into the building's concrete structure. As a result, when ground anchors reach the end of their design life, there is a risk that the structure could experience significant movement, potentially leading to structural issues or failure.

As an example, a failure of a 23-year-old lateral support system recently occurred at an apartment block in Clifton where a Rooiels tree's roots resulted in the opening of a void between the shotcrete facing and the rock. This resulted in a waterfilled void inducing failure of the shotcrete facing due to large hydrostatic forces. The repair required the use of equipment capable of working in confined spaces.

In addition, at another apartment block, exposure of some twenty geonails holding back terraced garden walls revealed them to be corroded almost right through, and all required repairs.

Recommendations for development

Given the challenges involved, the following recommendations for development are provided:

- During the concept design phase, first identify areas that can be excavated without the need to install grouted anchors into neighbouring properties. This approach will allow the architectural scheme to be developed in accordance with geotechnical constraints, rather than relying on neighbouring property permissions. As shown in this paper, achieving this will require innovative design solutions.
- Develop several design concepts to identify the solution that provides the optimal return on investment (total development cost versus selling price). In most cases, such developments do not maximise the potential bulk volume (see Figure 10). This process will require extensive collaboration between the geotechnical engineer, architect, structural engineer, and quantity surveyor.
- If the optimal solution extends to the property boundary or requires the installation of temporary or permanent anchors on neighbouring properties, it is recommended that the neighbours be consulted to obtain an in-principle agreement for such installations based on the concept design prior to submission of any plans to council for approval.
- The developer should suggest that neighbouring property owners appoint their own independent geotechnical engineer to review both the concept and detailed designs, with the developer agreeing to reimburse the cost of this review.
- Investigate whether a quid pro quo agreement can be arranged.
- Consider the 3D effects of excavation on adjacent properties.
- Only involve legal professionals if formal agreements, such as a notarial deed or servitude (permanent anchorage), need to be recorded, or if a formal agreement requires signing.

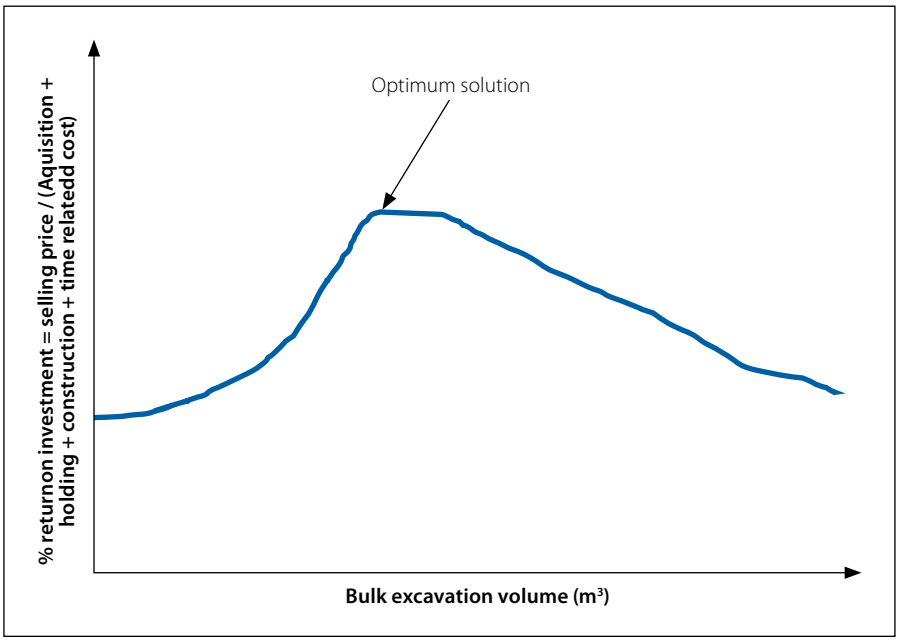

Figure 10 Optimal return on investment for developments on a sloping profile

Recommendations for maintenance

The following recommendations for maintenance are provided:

- It is recommended that the lateral support designer provide the owner or body corporate with a maintenance and inspection plan, ensuring that the responsibilities for the structure are clearly outlined for those who will take over its care.
- If permanent anchorage or lateral support systems are used, they must be accessible for inspection. Architectural designs should therefore include provisions for access chambers.

Other predictions

The following predictions should be considered:

- Many existing structures may undergo redevelopment, either through demolition or by undermining and underpinning the current buildings.
- Increased use of 3D FE analysis is expected to better understand the effects of construction on adjacent structures.
- There could be a trend of properties being bought out and merged into larger plots to make development projects more feasible, considering all the limitations posed in obtaining permissions.
- The city could modify its approach to allow permanent anchorage in POS, potentially further complicating development challenges.
- Design complexity will rise, requiring more top-down and partial-width construction solutions to provide lateral support, which will slow down construction and drive up costs.
- There will likely be greater reliance placed on using temporary internal propping and raking systems to stabilise cut faces during excavation.
- There is likely to be increased failure of unsupported cuts. □

REFERENCES

References have been excluded due to space limitation. A complete list of references can be obtained from the authors.