New Zealand Tourist Town Expands using Multiple Anchors and Actively Stressed Soil Nails for Slope Retention

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Queenstown, a beautiful lakeside resort is surrounded by impressive mountain peaks and ridges, with such evocative names as “The Remarkables” (Plate 1). Development of the level shoreline areas reached capacity several years ago and like other “Alpine” resorts, modern expansion encroaches into hillside areas. The demand for lake and mountain views from multilevel developments requires the excavation and the retention of steep or vertical cut faces. The rigid or flexible facings are being supported by the latest technology in soil nail and ground anchor practice.

Soils typically comprised of dense silty sands with gravel but, in areas where they incorporate weak alluvial silt bands, the interbedding poses a problem for the slope designer. These mixed overburden materials are typically underlain by weathered schist of varying degrees of degradation and thickness and not necessarily appropriate for high bond capacity. Furthermore, this area is subject to seismic disturbance, an additional difficulty to be accommodated in safe design of steepened slopes.

Recently, foundation contractor, March Construction, completed his first town centre development, and chose to use Single Bore Multiple Anchors. The 96 anchors each comprising of a multiple of short bond
lengths were installed using post grouting techniques. They exhibited excellent load holding characteristics and, experienced very low creep losses during the proof loading operations (Plate2).

March’s Managing Director conceded that “This successful anchor system could be nearly as successful as the All Blacks” – a compliment indeed from a New Zealander. Manager, Pavel Bilitchenko, an experienced anchor installer from several years of intense foundation development in Berlin, is well satisfied and has proposed the system usage in two imminent developments, both requiring particularly high load soil anchors. Albeit even he considers the 5000kN capacity recently achieved in soil anchors in Dublin to be almost beyond belief.

April of this year marked the System’s Licensee; Austress Menard Pty’ completion of the first trials on the Actively Stressed Soil Nail in a selected Queenstown slope. This nail system complements the multiple unit anchor concept of the SBMA’s.

Early development of UK soil nailing technology utilised fully bonded, passive tensile members for retention of active zones of soil. Surface soil slippage was initially controlled by placement of geogrids or similar materials over the exposed slope surface, and the grid often restrained by driven pins (Figure1).

As confidence in soil nail technology increased, cut faces became steeper and surface soil retention extended to semi-flexible and stiff facing systems; most commonly provided by shotcreting. The concept of constructing the facing and leaving both the face retention and the soil nail in a passive state, gave Engineers reason for concern. Face movement would initially be required to develop the nail
retention forces, and subsequently active movement within the soil would take place in order to generate tension in the deeper component of the passive nails. The simplest and most practical solution appeared to be the consideration of the head of the nail as an anchor which justified the application of prestress (Figure 2). However, load cannot be applied to a bonded elastic tensile member without the occurrence of debonding progressively along the nail. This results in the applied face retention force being resisted by load transfer into the active zone of the soil mass.

The new “Actively Stressed Soil Nail” is developed to ensure that the face retention force is transferred entirely into the resistant zone of the soil mass which is consistent with the original principles of wall retention. This is effected by the installation of two tensile members in each nail bore; one being actively stressed against the face and bonded in the resistant zone. The second member passively ties the active zone soil to the resistant zone consistent with soil nail technology (Figure 3).
The two tensile members in the borehole are fully isolated from the environment, by their in-situ encapsulation within a plastic corrugated duct. This complies with the latest code recommendations and eliminates tendon corrosion this increasing life expectancy of the nail.

Furthermore it has potential benefits in areas subjected to seismic disturbance.

In Queenstown, the Active Soil Nail System was proposed for both stabilisation of the soil mass and for the prestressed retention of the 14m high 80 degree inclined Shotcrete face (Plate 3).

Seven rows of actively stressed nails are to be used in conjunction with a single row of toe level SBMA anchors. The nails are founded in the silty sand and gravels; the multiple anchors in the weak underlying alluvial silts.

Trials supervised by Single Bore Multiple Anchor Ltd have been completed on the new nail system, achieving load capacities as high as 864kN without failure in the distal 6m length of a 12m long nail (Plate 4). Tests on the short fixed length post grouted multiple anchors, investigated ultimate bond capacity in the weak silts. They attained between 544kN (failure) and 864kN without failure (264 to 400 Kips).
In Europe Keller, the UK patent holder is preparing for UK trials on the Actively Stressed Nail System. In Hong Kong liaison is currently in progress for trials supervised by the Landslip Investigation Division of the Geotechnical Engineering Office. The area of Queenstown already has its “remarkable” mountain ranges, but the local Geotechnical Engineers are hoping for remarkable anchor and nail systems to stabilise the new developments subjected to seismic loading conditions.

For more information see:

www.SBMASystems.com

www.TheAnchorman.com