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GeoCompaction Dynamics provided lateral support for an upmarket four-storey apartment development with two basement levels in East London. New-technology design, incorporating hollow bar soil nails, 450 kN active anchors, and reinforced gunite, was adopted to retain the 8 m high vertical excavation in the non-cohesive soil conditions typically encountered in coastal regions.

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'I HAD A VAC JOB with Franki (or Frankipile as it was then known), since I was about 10 years old – at first passing spanners to the mechanic’s assistant, then later driving a dumper, and eventually working in the estimating department,’ Bernie says.

His early Franki exploits were linked to his father having accepted a job with the company in 1964. The Krone family had immigrated to South Africa three years earlier from Halstead, England, where Bernie and his sister were born, the offspring of the union between a German ex-POW and a member of the British Women’s Auxiliary Forces (WAF). Bernie remembers his parents with fondness, his father being the toughest man and hardest worker he has ever known; his mother being the driving force behind the children acquiring a good education. ‘She always used to say, manners maketh the man,’ he recalls.

LIVING LIFE WITH GUSTO

Ever since he can remember, Bernie wanted to be a construction engineer, but the road that led there had a few twists and turns. The crowd that he mixed with as a youngster were all getting married at an early age and 18 year old Bernie, then a first-year BSc Civil Engineering student at Wits, followed suit. ‘My eldest son was born when I was in my second year, and my second son in my final year,’ he says.

He was studying with an LTA bursary and was employed by the company during university holidays, working on the outfall sewer arch bridges at Diepsloot, north of Johannesburg, among others. However, when he failed two subjects in his third year and had to find a full-time job to provide for his young family, LTA didn’t have anything readily available. ‘That’s when I ended up working as an assistant to the chief estimator at Franki, doing piling estimates, contract establishment and surveying. But the year wasn’t lost because I learned such a lot about pricing contracts,’ he says. ‘Having to repeat a year of study also had its benefits, because I then caught up with the class of 1975, with whom I fitted in better. I’m a bit of a lively character – outgoing, extrovert, loudmouth, love socialising, always last to leave – and I identified with several of those guys,’ he says, laughing heartily.

In 1976 he joined Ground Engineering Limited (GEL), the geotechnical contracting division of LTA, as a graduate civil engineer, gaining experience in the technique of pipejacking, as well as lateral support and ground anchors. Projects on which he worked at the time included lateral support structures for the Johannesburg Stock Exchange and the demolition, excavation, piling and lateral support of the Johannesburg Municipal Pension Fund building.

The year 1997 saw him transfer to GEL’s piling and foundation engineering division. Singling out a project in this era that he regards as a highlight in his career, he recalls his involvement in the sheet pile coffer dams for the Baddrif bridge on the Vaal River, between Vanderbijlpark and Sasolburg. ‘In several respects it was a bit of a nightmare, because problems kept cropping up on site,’ he remembers. ‘Although work of this kind is always a team effort, I think I established myself as somewhat of a live wire on the Baddrif project, making sure that I was down at the coalface, getting things smoothed out and running efficiently,’ he says.

Dr Ross Parry-Davies, who was MD of GEL at the time, recalls an occasion on
which Bernie saved the day on that project: ‘A 20 ton pontoon, on which we had a large crane and a compressor, had broken its moorings during a storm, and was being held by one steel wire rope only, while being pulled by the raging river towards the existing bridge. If the bridge had been taken out by the pontoon, it would have been a disaster. Bernie volunteered to be lowered from a helicopter to tether a cable to the pontoon and carry it to the river bank, so that the pontoon could be hauled away from the main force of the water and secured to the river bank. It was a hazardous operation, but Bernie, who was always game for any challenge, went into the situation with vigour and enthusiasm.’

By 1979 Bernie felt that he had a firm enough grasp of the construction side of engineering, but that he lacked the design experience he needed to obtain Professional Engineer certification. He reached an agreement with GEL that he would join Watermeyer Legge Piésold & Uhlmann for a year, working as a project engineer on tailings dam management, slimes dams and reinforced concrete design. Six months in consulting engineering was enough to convince him that he was ‘not a great design engineer. I’m a round peg in a round hole; I have to be a contractor,’ he says. Even so, his work brought him into frequent contact with the design side, and his grasp of a situation included a natural and instinctive feel for what is workable and what will not be a practical solution.

Dr Parry-Davies recognised this quality in him. ‘Not many young civil engineers have this intuitive grasp of geotechnics from day one, but Bernie showed his natural skills right from the start,’ he says. So when Dr Parry-Davies asked Bernie to return to GEL, he was only too happy to oblige. He rejoined in November 1979 as contracts manager in charge of the ground engineering division.

**CHALLENGES AND SUCCESSES**

The expertise he had acquired in lateral support was a major reason that he was recruited in 1981 to join what was then the Transvaal division of Esor Ground Engineering as a director, specifically
tasked to launch the company in geotechnical techniques other than pipejacking.

‘One of our first jobs was the base-ment excavation and lateral support for the South African Reserve Bank in Pretoria,’ Bernie recalls. It is at this point that the concept of being in the right place at the right time enters the picture. ‘I had a very good relationship with the guys from Pretoria Excavating Contractors and they backed us as the preferred subcontractor on the project. It was a huge con-tract for us – in the region of R1.2 million – which was good money in those days. That project really set us off on the road to success,’ he says.

Bernie has happy memories of the early 1980s. ‘There were three of us in the Johannesburg office – me, Peter Sharland and the bookkeeper – but we had only two desks and two chairs, so we had to carefully plan who would be in the office at any one time. Every Friday afternoon we would go out in person to deliver tend-ers by hand. In a way those times were actually more exciting and less stressful than today, when you are inundated with e-mails, ringing cellphones and SMSs. One doesn’t have time for introspection and reflection any more; you are on call all the time,’ he reflects.

On the personal front, his life entered a new, enriching phase when he met and married his second wife, Martie. ‘When my brain was ticking over in highest gear, especially on that Reserve Bank project, she would play backgammon with me in the early hours of the morning to help me clear my mind.’ The couple are celebrating their 25th wedding anniversary this month, and have four children: Jessica (23), Benjamin (19), David (16), and Katy, who has just turned 15. From Bernie’s first marriage there are Andrew (35) and Robert (33), who both live in the UK. ‘That marriage didn’t survive – I guess we simply developed in divergent ways – but I have these two wonderful boys from that union. If you work it out, between the children of my first and second marriage I’ve had about 40 years of PTA meetings,’ he chuckles.

In calling to mind significant projects from the 1990s, Bernie says: ‘Funnily enough the defining moments are not necessarily jobs that have gone well. Some come to mind because they have been so challenging; where we simply had to persevere and see that the work gets completed against adversity. I’m always quite amazed by the spirit of man – that somehow things get done, no matter how difficult. I guess the guys who built the pyramids had the same sort of experi-ence,’ he smiles.

In this vein he sites the Malvern Tunnel, on which he was the project director, and which ‘turned his blonde curly hair grey’ over the two years that it was in progress. ‘The project was done in joint venture with SAMAT (SA Mining and Tunnelling) for Rand Water, to bring potable water from their pumping station at Palmiet to Pretoria and northwards. In the 2,6 km section we were involved in, between the Cleveland off-ramp on the M2 and the Kensington golf course, a lot of drilling and blasting had to be done. So we brought in an inline road header from Germany at great cost. We almost went to the wall with that job,’ he grimaces. ‘We had an overdraft and a joint venture account of about R4.5 million, and the bank was going to foreclose on us on the Monday. On the preceding Friday we submitted a claim to Rand Water and they paid us R10 million against the claim. So we got the money just in time.’ This project eventually set all existing pipe-jacking production and length records in South Africa, and Bernie still regards it as his best achievement, professionally speaking.

Peter Day, of Jones and Wagener Consulting Engineers, who has worked with Bernie on design and construct contracts for over 25 years, says: ‘He is prepared to accept risks and their conse-quences, and to act decisively. In all the years that I have worked with him, his judgement – which is often based on the simplest of calculations – has proved to be sound. His modus operandi has always been the same: invest in a thorough tender design, devise a practical solution to the problem, and then submit a lump-sum price. Many of the projects we have been involved in have been awarded not on the basis of price, but as a result of this professional and confident approach.’

**ESOR: FROM STRENGTH TO STRENGTH**

The next phase in Esor’s evolution had an unforeseen start. When the MD and majority shareholder, Joe Rose – who lent his name (spelled backwards) to the company – died in a pay heist in their Durban offices in 1990, Bernie and the five other directors, who were minority shareholders, suddenly found themselves the owners of the company. Once again, although the circumstances were tragic, luck had played its hand. ‘The changed status quo enabled us to express ourselves directly and we had much more control to steer a different course.’ In time, one of the six directors retired, and one left for Australia. ‘We are like the Four Musketeers, with the spirit of all for one and one for all permeating the ethos of the company,’ Bernie says.

This spirit didn’t change when Esor listed in 2006 on AltX, the alternative ex-change for small companies. ‘The decision to list stemmed from several factors, one being the failure of several attempts to take a BEE partner on board. Financially we were a well-managed company, but we had always been averse to getting into debt to obtain financing. When we were trying to do a BEE deal, we looked at selling some of the company, as well as several other options, which in the end weren’t feasible. Another factor was disa-greement about the value of the company. So our brokers advised us to forget about BEE for the time being and to consider a listing first, which would enable us to test the value of the company on the market,’ Bernie elaborates.

The listing was a phenomenal success. ‘We put 20 million shares on the market and were oversubscribed 60 times,’ he says. ‘Then Franki came up for sale – I mean, can you wish for a better position to be in!’ The injection of capital enabled Esor to acquire Franki for R170 million, paid for with R137 million in cash and the balance in Esor shares.

Between Esor and Franki they now have about 40 % of the specialist civil engineering market, and turnover is expected to be in the region of R1 billion this year. ‘We’re doing a joint venture on the Gautrain project, so we’re still oper-ating separately, but there are synergies in things like skills and spare capacity,’ says Bernie. ‘We’re involved in all the sta-tions, the Marblborough section, where it goes under the N3, the Airport, Midrand, Centurion – really the whole stretch – as well as the stadiums. I always say, we’re like the ball boys at Wimbledon; we’re not the major stars but we’re at all the big matches. And what’s nice, we’re always the first people in when everybody is still happy,’ he remarks cheerfully.

The mantle of CEO of Esor fell on Bernie’s shoulders in quite an unorthodox way. ‘The CEO position was a bit of a
complication for us; up to the listing we never had an MD after Joe’s death. The four of us all have different strengths and contribute in diverse ways. But since three are Durban-based and I’m the only one in Johannesburg, I was conveniently located to fill the hot seat. We also needed somebody that could talk to people – the media, investors, doing presentations – and I fitted the bill. For me, the bigger the audience the better. But you’ve got to do it with passion, and I am very passionate about the company. I believe in Esor and in what we can deliver. I’m a seriously positive person,’ he emphasises.

He is also, he says, a bit of an action man. As his personal best achievement he cites completing the Big 5 Millennium Challenge in 2000, consisting of the Dusi canoe marathon, the Midmar Mile, the Argus cycle tour, the Comrades marathon, and climbing Mount Kilimanjaro. ‘I did my first Dusi in 1980; I did it with my wife again in 1983, and since 2000 I’ve done it every year.’ He’s also done the last 14 Argus tours in a row. Kilimanjaro too he’s climbed twice, the first time with his wife. ‘Martie loves travelling, so if it involves climbing a mountain, she’s game for it.’

One thing he doesn’t consider himself to be is the academic or lecturing type. ‘In contracting, my life is about delivering projects on time,’ he says. However, in 1991 he was one of a group of contributors who received the Jennings Award for the updated version of the South African Code of Practice on lateral support in surface excavations. ‘Soil mechanics was not one of my strong points at university and I just managed to scrape through exams. If Pappy J, as we students called him, knew that one day I would be receiving an award carrying his name, he would have rolled over in his grave a few times,’ Bernie chuckles.

‘A bright young man who gave the superficial impression of being wild and undisciplined,’ is how Dr Parry-Davies described his protégé in his twenties. Recently he was depicted in the Financial Mail as ‘dominating the space around him much like the giant construction equipment his company works with.’ The energy field that surrounds Bernie Krone is undeniable and contagious.
Are we getting what we pay for from geotechnical laboratories?

Geotechnical engineers use the results of soil tests when assessing the likely behaviour of foundations and other geotechnical structures and assume professional responsibility for these assessments. But how reliable are the results they receive from the soils laboratories? This article compares the results of basic soils tests on two samples sent to four commercial soils laboratories in the Gauteng area in late 2006. The variation in the values obtained was sufficiently wide to lead to an incorrect assessment of soil behaviour. A follow-up trial was carried out at the beginning of 2008. No improvement in the consistency of results was noted. Possible ways of addressing this problem are explored.

FOUNDATION MOVEMENTS of a single-storey industrial structure in Mpumalanga led to re-testing of the founding soils. When significant discrepancies were noted between the original test results and those from the repeat tests, the accuracy of both sets of results was questioned.

To assess the reliability of the results, identical samples of a clayey and a sandy soil were sent to four Gauteng-based soils laboratories in 2006. Care was taken to ensure that the individual samples were identical by passing them through a riffler and re-combining them four times before splitting the sample into four approximately equal parts which were then submitted for testing. The laboratories were requested to determine the particle size distribution to clay fraction (0,002 mm) and to determine the Atterberg limits and the specific gravity of each sample.

These comparative testing trials were repeated early in 2008. The results of both trials are presented below.

COMPARISON OF RESULTS: 2006 TRIALS

Particle size distribution

Figure 1 presents the particle size distributions for the clayey sample obtained from the four laboratories. Three results correlated relatively well, but one indicated a substantially coarser grading than the others below a particle size of 0,425 mm. Although not evident in these results, a common problem is a discontinuity in the grading curve at 0,075 mm, the transition between the sieve and hydrometer parts of the grading analysis. Lower fine fractions than would be expected from a smooth extrapolation of the coarser part of the grading curve could indicate incomplete dispersion, possibly as a result of problems with the dispersing agent.

In the case of results from Lab 2, a change in slope is evident in 0,425 mm, possibly indicating that fine particles clinging to the coarser material have not been adequately washed through the 0,425 mm sieve.

Figure 2 presents the particle size distribution curves for the sandy sample.
Surprisingly, a wider scatter is evident than was the case with the clayey sample. The percentage passing the 0.425 mm sieve varies by more than 20%. This is all the more significant when it is realised that the <0.425 mm fraction is the fraction on which the Atterberg limits are determined.

**Atterberg limits**

Figure 3 presents the liquid limit, plastic limit, plasticity index and linear shrinkage for the clayey material received from the four laboratories. The liquid limit varies from 53 % to 78 %, the plastic limit from 30 % to 42 % and the plasticity index from 16 % to 45 %. Owing to the variation in the initial moisture content at which the material was placed in the shrinkage troughs, wide variations in linear shrinkage values were reported (9 % to 18 %).

The results for the sandy sample are presented in figure 4. Again wide variation is evident, with two laboratories classifying the material as non-plastic, while the others reported plasticity indices of 7 % and 1 % respectively.

**Specific gravity**

The laboratories were also requested to measure the specific gravity of both the clayey and sandy samples. In the case of the clayey sample, values were found to vary from 2.66 to 3.07 and for the sandy sample from 2.66 to 3.34.

Figure 6 presents the Van der Merwe heave chart, indicating potential expansiveness, based on the plasticity index of the whole sample and clay fraction. Owing to the relatively low clay percentage, all results fall within the medium expansive zone. However, had the clay percentage been higher, that is, around 30 %, the large variation in PI would have resulted in the potential expansiveness ranging from low to very high.

**2008 FOLLOW-UP TESTING – HAS THE SITUATION IMPROVED?**

Early in 2008, a second set of two samples was again sent to four Gauteng-based laboratories. The first sample comprised a highly active sandy clay containing some calcretised material, and the second sample was a silty sand. The laboratories were requested to carry out grading analyses including the determination of the clay fraction (<0.002 mm) and to determine the Atterberg limits.

Since carrying out the first set of tests in 2006, one of the above laboratories has closed down. The new laboratory added to the list is referred to as Lab 5. Note that all four laboratories claim
to be accredited by the South African National Accreditation Agency, SANAS.

**Particle size distribution**

The grading curves for the clayey samples are presented in figure 7. Reasonable agreement was obtained down to a sieve size of 0.075 mm between three of the laboratories. It is suspected that Lab 1 did not apply the wet sieving method correctly, resulting in an apparently much coarser grading. The hydrometer sections of the grading curves differed substantially, with the clay content varying by more than 30%.

In defence of the laboratories it could be mentioned that the clayey material submitted for testing comprised a micro-shattered structure, causing lumps of material to break up very rapidly to approximately 1 mm particles when immersed in water. These particles did not, however, break up further even after having been left in water for several weeks. This was probably because of the presence of calcium carbonate in the soil which caused the 1 mm particles to be well cemented. Proper dispersion using a suitable dispersing agent and probably also acid treatment to break the calcium carbonate bonds (see Head 2006) were therefore important. The material was therefore difficult to test and the standard procedures as described, for example, in TMH1 would not have been adequate to ensure proper dispersion.

The arguments above do not, however, apply to the silty sand samples for which the grading curves are presented in figure 8. Relatively good agreement was evident between all four laboratories down to a sieve size of 0.075 mm. Wide scatter was again evident from the hydrometer part of the grading curves, with reported clay fractions varying by more than 15%. It appears that laboratories have difficulty in applying the hydrometer test correctly.

**Atterberg limits**

Figure 9 presents the Atterberg limits for the clayey sample. The most important parameter used in making decisions based on grading and indicator test results is arguably the plasticity index (PI). The four laboratories reported PIs ranging from 28% to 68%. Not one PI was within 10% of another and it is virtually impossible to determine from these results where the correct value should lie.

The situation in the case of the silty sand sample is nearly as disheartening. The Atterberg limits are presented in
Specific gravity values for clayey and sandy materials
Van der Merwe heave chart for clayey material
Particle size distribution of second clayey sample
Particle size distribution for second silty sand sample
Atterberg limits for second silty sand sample
Atterberg limits for second clayey sample
Van der Merwe heave chart for clayey material

Figure 10. Lab 4 reported the material as being ‘slightly plastic’, while Lab 1 reported a PI of 10%.

Should a contractor, for example, be interested to know if the material is suitable for the construction of the impermeable zone of an earth dam, the results from Lab 1 would suggest that it is (according to Van Schalkwyk 1991), while the result from Lab 4 suggests that it is definitely not! Taking correct decisions based on such results is clearly not possible and one cannot help but wonder how many decisions in recent years have been based on incorrect laboratory test results. Contractors and consultants are clearly being exposed to a possibility of damaging claims.

**WHAT SHOULD BE DONE**

Many reasons can be suggested for the large scatter in reported results. These include the condition of equipment, lack of adherence to standard procedures, absence of quality control, operator dependence of the tests and staff training. In some cases, there is doubt whether tests were done at all. In the authors’ experience at least one laboratory has admitted to simply reporting a linear shrinkage of about half the PI.

Clearly the above situation is unacceptable. The consumers of laboratory testing services could adopt a hard line and require laboratories to improve standards or close their doors. However, this would not solve the problem. Many laboratories are regarded by their principals as marginal, non-core activities and would probably choose the latter option. This would place further strain on a service that is already overloaded.

There are two observations that may assist us in resolving this dilemma. First, it should be noted that, despite the increase in demand for soil laboratory testing services, some laboratories have not increased their testing rates for over two years. Second, discerning engineers are queuing up for testing services rendered by academic laboratories who are able to deliver a testing service of the required quality, albeit at double the price.

In our opinion, the commercial testing laboratories have allowed themselves to stagnate for too long. As far as can be seen from the outside, there has been little or no investment in staff training and new equipment. Many of our laboratories are still using equipment that was manufactured in the 1960s, using mechanical measurement devices and recording data manually. Significant recapitalisation is long overdue.

The message the authors would like to send to the laboratories is that the geotechnical fraternity is prepared to pay the price required for laboratory tests that are executed in accordance with the acceptable standards using modern equipment operated by well-trained staff. What is needed is a commitment from the commercial laboratories to respond to the challenge.

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Soccer City Stadium
Supporting the 2010 World Cup

THE SOCCER CITY STADIUM in Johannesburg, formerly known as the FNB Stadium, is at present being upgraded at a cost of R1.5 billion.

The stadium is earmarked to host five first-round matches (including the opening match), one second-round match, a quarter final and the final of the 2010 FIFA World Cup. The new stadium will have an official capacity of 94 700, making it the biggest stadium ever to be used in a FIFA World Cup.

Aside from completely renovating the existing stadium, the boxes and upper seating, which were previously only on the western side of the stadium, are being extended around the entire perimeter. A circular steel roof is to be added, giving the stadium the distinctive calabash shape envisioned by the architects. Owing to the round shape of the roof, it will be largely independent of the stadium structure and supported by twelve reinforced concrete ‘shafts’. These shafts and the loads generated by the roof have resulted in exceptionally high loads being transferred to the foundations, with the design and construction of some of the most extreme piles ever installed in South Africa.

Once the piling is completed, 1 325 piles will have been installed, along with lateral support for three cut-and-cover tunnels that are at present being constructed through both existing and new portions of the stadium.

To provide some idea of the scale of the project, it is worth considering that over 20 km (20 317 m, to be exact) of pile shaft has already been installed by GEL, the specialist geotechnical division of Grinaker-LTA, who has completed the geotechnical construction work over the past 14 months. This has required the placing of 13 000 m$^3$ of 40 MPa concrete for the piled foundations alone, as well as 1 132 tonnes of high-tensile steel.

TENSION PILES AND SHAFT FOUNDATIONS

While many of the piles carry large compressive loads, perhaps the most daunting aspect of the pile design has been the exceptionally high-tension loads. The calabash-shaped façade transfers all the load from the roof down twelve reinforced concrete shafts and 120 backward sloping façade columns constructed around the perimeter of the stadium.

By way of an example, a single shaft foundation is required to carry up to 13 000 kN of tension, combined with 6 000 kN of shear and 125 000 kNm of moment. Given the limited space, it was only possible to install a maximum of 12 piles per shaft foundation with the result that some piles were expected to carry up to 5 800 kN of tension.

Unfortunately the rock strength and depth across the site is highly variable, and therefore only limited capacity can be safely generated in the rock socket.
Cantilevered steel trusses are used for the roof. The Western Tunnel mid-way through excavation, construction well advanced on the southern side and mesh. As a result of the construction support comprising soil nails, shotcrete adopted a similar system of permanent lateral programming constraints it was decided to Tunnel are being constructed through the stadium structure above. The distinctive calabash shape of the stadium utilises cantilevered steel trusses for the roof. Erection of these trusses will be done using a 600 t Terex Demag 2800 crane. This massive piece of equipment has two tracks, each with a footprint of 10 m x 2m and imposes ground pressures equivalent to a medium-size office building (that is, up to 550 kPa while in operation). These high stresses were a major concern, given the typically poor strength of the soil near ground level and the consequences of a bearing capacity failure. One engineer on site jokingly stated that if the crane were to collapse, we ‘better make damn sure it doesn’t land on the stadium’. To avoid this scenario altogether, an evaluation was undertaken to assess the bearing capacity of the soil and the requirements for any remedial action.

Investigation
The stiffness of the substrata was assessed by performing some 50 No 2 m deep dynamic cone penetrometer (DCP) tests. The DCP profiles generally revealed very similar results. The most conservative test was found to indicate that the in-situ materials to 2 m depth, exhibited California bearing ratio (CBR) values in the range 15–20. This would indicate that the in-situ Young’s modulus would be given by:

\[
E = 100 \text{ MPa}
\]

The design shear strength parameters for this material are therefore likely to be in the order of:

\[

c = 15 \text{ kPa} \\
\phi = 35^\circ \\
\gamma = 20 \text{ kN/m}^3
\]

Using bearing capacity formulations for the crane track placed at the shoulder break point of an embankment, factors of safety were calculated in the range 0.65 to 1.75 for slope angles of 1:1.5 to 1:2.0. Thus small changes in the slope angle lead to very pronounced changes to the calculated safety. The factor of safety (FOS) drops below the critical FOS = 1 value when the slope angle exceeded about 1:1.7.

A more advanced finite element model was used to accurately depict the situation which would occur in practice. Here the 250 kPa stress exerted by the track in the transport mode over a 2 m wide area, 2 m from the edge of the embankment, was modelled. This analysis yielded factors of safety of 1.53 for the 1:1.5 slope to 1.75 for the 1:2.0 slope.

From these results it is obvious that in moving the load from the edge of the slope to 2 m from the edge has a highly beneficial effect. Not only are generally higher safety factors predicted, but the range of these values is much lower.

DISCUSSION
While the above FEM analysis may generate the idea that the ramp area that will be traversed by the crane in the lower bearing stress mode is safe, the bearing capacity formulations indicate that extreme caution is necessary when the load moves towards the outside of the embankment. Owing to the extreme sensitivity of the situation, it was felt that a very cautious approach should be adopted and the recommendations included limiting ramp side slopes to shallower than 1:1.75, making the ramp sufficiently wide to ensure 3 m of space between outer edge of track and shoulder breakpoint of the fill is maintained.

In order that horizontal tensions exerted by the crane were not transferred to the fill substrata, a layer of high-strength geosynthetic has been specified over the top of the fill prior to a wearing course being placed. A wearing surface comprising a 300 mm thick layer of G5 gravel, compacted to 93 % Mod AASHTO, has been specified.

CONCLUSION
The stadium is currently progressing well, with some areas actually slightly ahead of programme. That said, there remains some big challenges ahead, particularly in the complex erection of the steel roof structure.

There is no doubt that the professional and construction team will continue with their present commitment, looking forward to completing this iconic structure which will be viewed by billions of people in only a couple of years’ time.

1. Cantilevered steel trusses are used for the roof
2. Construction well advanced on the southern side
3. The Western Tunnel mid-way through excavation
4. Construction of North-east Tunnel lateral support
Submitted by: Trevor Green (geotechnical principal, Verdi Consulting Engineers); Alan Parrock (geotechnical principal, ARQ Consulting Engineers); Alan Scott (site agent, GEL Geotechnical Contractor); John Masters (technical manager, Grinaker-LTA)
Foundations for the roof support arch for Durban’s 2010 World Cup stadium

AN ARCH THREE-QUARTERS of the length and height of the main span of the iconic Sydney Harbour Bridge will be the most visible feature of Durban’s new Moses Mabhida stadium. At time of writing, the foundations had been constructed and erection of the arch was imminent.

The 380 m long arch will provide a frame for the harp-like array of cable-stays supporting the grandstand roof. The wishbone-shaped arch has three spring-ings, one at the northern end and two at the southern end of the major axis of the stadium.

Because of the tension forces in the cables, the design loads are exceptionally large for such a slender structure. To resist horizontal loads of up to 100,000 kN, with minimal deflections, the foundations are 20 m deep shear-walls socketed into bedrock.

SITE GEOLOGY
The site in King’s Park is quite flat at a level of about 4 m above mean sea level, except where raised by filling. Groundwater is a metre deep, or less after rain. Slightly clayey silty fine sands known locally as the Harbour Beds extend down to a relatively flat erosion surface on Cretaceous siltstone at 18 m to 20 m depth.

Hard rock boulders scattered towards the base of the Harbour Beds did not influence the design but were a nuisance to Esor, who constructed the diaphragm walls. The siltstone, beneath a thin (less than 0.5 m thick) mantle of stiff residual clay, comprises inter-bedded thin, or very thin, layers of very-soft (UCS = 1 MPa to 3 MPa), soft (3 MPa to 10 MPa) and harder (>10 MPa) rock. Exploratory boreholes drilled a few metres into the siltstone did not reach the underlying Dwyka tillite.

THE DIAPHRAGM WALLS
The foundations are elongated rectangular boxes with 0.8 m thick reinforced-concrete walls. The northern foundation is 44 m by 7 m in plan and the two southern foundations are each 30 m by 4 m. The walls were excavated and cast under bentonite slurry (drilling mud) in panel lengths of up to 7 m. Alternate (primary) panels were cast as independent barrettes with tubular stop-ends to form concave half-round shear keys. In excavating the infilling (secondary) panels, after removal of the stop-ends, the revealed concrete surfaces were scraped by the bladed shoulders of the excavator grab-tool. Some bonding of the concrete is expected to occur between panels but there is no reinforcing across the (vertical) construction joints.

In addition to vertical and horizontal reinforcement each wall panel contains four or more vertical multi-strand post-tensioning cables.

The vertical reinforcing is fully bonded into, and the strands extend through, the deep (3 m on the south foundations, 5 m on the north) capping beams, which are also post-tensioned.

Each wall-panel is embedded at least 0.5 m into siltstone with a compressive strength of 2 MPa or stronger. These rock sockets have been ignored in assessing resistance of the foundations to sliding and over-turning, but were considered necessary to ensure adequate bearing capacity.

STABILITY ANALYSIS
The critical loads imposed on the foundations were determined through structural analysis of the roof for a large number of load cases including wind, cable prestress, self weight, maintenance loads, temperature effects and imposed loads. Many of the design load cases (approaching one hundred in total) related to the staged construction process for the slender arch. Because the dominant loads will be cable forces, controlled by the erector, a load factor of 35 was adopted. However, the resultant loads were multiplied by an ‘analysis uncertainty factor’ of 1.1 so that the ‘global’ load factor was slightly less than 1.5.

As shown graphically in figure 4, for most of the load cases the in-plane horizontal component is proportional to the vertical component. This is because the
The Durban Stadium arch and foundations silhouetted on a view of Sydney Harbour Bridge
Twenty tonne reinforcing cage
Key plan showing topology and foundation layout of the stadium arch and roof
Comparison of in-plane horizontal and vertical components of load
Summary of heaviest load components

Arch has been designed to be predominantly in compression at all times.

The load case with the largest horizontal (destabilising) component is summarised on the load diagram of figure 5.

In-depth consideration was given to finding an appropriate method for proving the stability of the foundations with regard to rotational (over-turning) and translational (sliding) stability. Consensus was eventually reached within the design team on lateral earth pressure coefficients and reduction factors appropriate to disturbing (active) forces and restraining (passive) forces.

- Because lateral deflections of a few centimetres will influence the structural behaviour of the arch, passive pressure coefficients were clearly irrelevant and were replaced by ‘at-rest’ pressure coefficients.
- Active pressures were determined in accordance with conventional earth pressure theory.
- In assessing the potential for sliding, the cohesive components of strength of both the Harbour Beds and the Cretaceous siltstone were ignored.
- The weight of soil contained within the diaphragm-wall box was taken into account with regard to sliding, but excluded from the assessment of overturning.

Guidance by Peter Day, of Jones and Wagener, on how to present the analysis in a manner compliant with Eurocode EN7 and SANS 10160 (now in draft) is gratefully acknowledged.

**CALCULATION OF DEFLECTIONS**

**Analytical method**

The load-deflection behaviour of the foundations was analysed using PLAXIS 3D FOUNDATIONS’ version 1.5 (current at January 2007) which applies finite element elasto-plastic techniques for calculation of soil–structure interactions.

**Strength parameters**

PLAXIS is a geotechnical (not a structural) design package and has limitations with regard to the modelling of reinforced concrete. The post-tensioned pile-cap was modelled as a linear-elastic (no crack) material.

The reinforced concrete of the diaphragm wall panels was defined to comply with Mohr Coulomb failure criteria expressed as a shear strength of 20 MPa (zero friction angle) and a tensile strength of 5 MPa. The tension cut-off was introduced to limit unrealistically high stresses predicted to occur in the bottom corner of each panel, as can be seen towards the bottom of figure 4.

The construction joints between diaphragm wall panels were modelled as thin inter-face elements with a fraction (in this case 1 %) of the strength of the parent material.

**Elastic parameters**

The elastic modulus of the Harbour Beds was assumed, as proposed by Stroud (1989), to be the characteristic standard penetration test ‘N’ value multiplied by 0.8 MPa.

No published data could be found on the elastic properties of the local Cretaceous siltstone. Guidance was sought from a Ciria report by Gannon et al (1999) and Tony Brink’s *Engineering geology of Southern Africa* (Brink 1983). It was concluded that the value of Young’s modulus is likely to be at least 160 times the UCS.

**STRUCTURAL ANALYSIS**

PLAXIS does not have element types to model the reinforcing in concrete, but the forces induced in the reinforcing were assessed by multiplying the area under...
consideration by the stresses calculated to act on that area. Zones of high stress were reviewed to confirm that plastic yield (crushing or shearing) of the concrete would not occur except, as allowed for, in the construction joints between adjacent panels.

Further analysis was done using PROKON\(^2\) (both frame analysis and plate analysis) and STRAP\(^3\) (structural analysis package). STRAP was used for the composite design of the reinforcing and post-tensioning in accordance with TMH 7 Part 3 (1989), ‘Code of Practice for the Design of Highway Bridges and Culverts in South Africa’.

PROKON provided a useful link between STRAP and PLAXIS to demonstrate strain compatibility between the structural and geotechnical analyses.

CONCLUSIONS
The deflection tolerances of a few centimetres under enormous lateral loads presented an interesting design challenge. There remain areas of uncertainty, such as the degree of interlock between adjacent diaphragm wall panels and creep deflections of the foundations under sustained load. To deal with these uncertainties hydraulic jacks will be built into the arch springings and deflections will be carefully monitored during and after construction of the arch. It is hoped that these measurements and their influence on the construction and maintenance of the arch will be discussed in a sequel to this article.

Notes
1 See http://www.plaxis.com/.

References

\(^{1}\) PROKON output showing deflected shape of diaphragm wall
\(^{2}\) PLAXIS output showing vertical stress distributions in diaphragm-wall

\(^{2}\) PLAXIS output showing vertical stress distributions in diaphragm-wall
Construction starts on geotechnically challenging N17 freeway link for 2010

CONSTRUCTION HAS RECENTLY STARTED on the new N17 freeway link in Soweto, with site establishment and enabling works under way. The 5.8 km freeway link will provide much-needed access from the N1 to Soweto and the Soccer City and Orlando stadiums.

The approximately R400 million design-and-build contract is a contractor-consultant joint venture between Group Five and Vela VKE. Funding is provided by Sanral and is programmed to be completed before the 2010 FIFA World Cup.

The project presents numerous geotechnical challenges along the relatively short link road; besides several large bridges over challenging geological terrain, there is a deep cutting through an existing tailings dam, a large fill constructed with tailings, and some shallow undermining. In addition, a significant portion of the route is being constructed on an existing tailings dam and in close proximity to two other large tailings dams.

All of this is not forgetting the challenges in constructing a road pavement structure on tailings, the aggressive nature of the soils and water in the area towards concrete and cement, together with the regular challenges of delivering such a project to a tight design and construction programme.

ROUTE AND PROJECT DESCRIPTION

Figure 1 shows the N17 Link Road alignment. The two-lane dual carriageway (four lanes in total) tees onto the Soweto Highway at Klipspruit Valley Road (near Orlando Stadium) and for the first 1.5 km is aligned in the floodplain of the Klipspruit whilst dipping below the existing New Canada Railway and later New Canada Road. Here four bridges are provided, one of which will be a large twin portal bridge with spans of 11 m which is to be jacked below the railway line.

The remainder of the route is aligned west-east towards Nasrec Road, through a derelict mining area; crossing shallow undermined land and cutting through an existing tailings dam in which two substantial cuts are located. It is here, between the two cuttings, that the N17 crosses over the existing N1 (Western Bypass) and a partial interchange is provided with north-facing access to the N1 only. It is also here that the route approaches the currently operational Mooifontein and Diepkoof tailings dams. Finally, the road tees in the east with Nasrec Road with a large at grade roundabout provided and with some upgrading and widening of Nasrec Road to improve access to the nearby Soccer City.

HISTORICAL BACKGROUND

The proposed N17 link is part of a future through route linking the current end of the existing N17 Toll Freeway at Wemmer Pan through the Witwatersrand mining belt in Johannesburg to
Mogale City (Krugersdorp) in the west.

Extensive planning and design of the N17 was undertaken in the 1980s and early 1990s by various consultants for the then South African Roads Board, with most of the current link road section corresponding to the section designed by BKS and a small section by Vela VKE.

Although there are benefits to implementing the full N17, in particular that it would provide an important east-west link south of the M2 Motorway, the route’s location through a built-up area makes this expensive.

**GEOTECHNICAL CHALLENGES**

The current project presents several geotechnical challenges over the relatively short section of road being constructed. This in itself also highlights the limitations which could be extended to the full route. Some of these challenges are the following:

- **Shallow undermining over part of the route** Fortunately for the link road, this only occurs over a small section of the route, less than 50 m. The stopes have been dewatered and are currently being backfilled using sand/cement slurry.

- **Materials balances** The shortage of adequate quantities of suitable road-building materials has required several iterative adjustments to the vertical alignment and to the cut-and-fill side slopes implemented, in order to optimise the materials usage. One such example is where the N17 cuts under New Canada Road; hard rock quartzite is encountered at shallow depth and the cut is designed deeper, wider and with shallower side slopes in order to generate additional good quality materials. The shortage of suitable road building materials has also necessitated the use of tailings for the construction of some of the fills.

- **Shallow rock and outcrop** It is seldom that shallow rock – in this instance hard rock quartzite – presents a problem for foundations and indeed, two of the six bridges on the route are founded on conventional spread footings at shallow depth. However, when the shallow rock is dipping steeply and a large bridge is to be constructed and then jacked across the dip on strike, it results in significant excavations being required and also affects the height of the bridge. Normal bridge clearance...
heights are in the order 5.2 m, but the dipping rock has added an extra 3 m to the bridge height, at the southern abutment where rock levels are much deeper. This makes the bridge to be jacked under the railway a significantly larger structure and one of the largest bridge jackings yet to be undertaken in the country. Shallow rock is also encountered at the site of the fourth bridge at New Canada Road and spread foundations will mostly be used. However, because of the presence of a 10 m wide, near-vertical diabase dyke, which presents as a weak compressible soil an innovative arched spread foundation (arching over the weak dyke and transferring most load to the quartzite) is proposed.

- **Bridges on weak compressible soils** A much more significant diabase dyke is also encountered at the site of the N1/N17 bridge and interchange. Here weak compressible soils are encountered to depths of up to 30 m where rock is encountered. The design has also needed to account for the negative skin friction forces resulting from the approach fills placed on the highly compressible soils. A driven precast pile solution is proposed at this bridge and at the sixth bridge, where compressible soils are also encountered, but to shallower depths.

- **High fills on compressible soils** The compressible soils also result in challenges where high fills (of up to 14 m) are constructed. In one instance settlements of up to 250 mm are predicted with most of the settlements taking in excess of a year to occur. The construction of these particular fills will be prioritised so that the settlements occur during construction and prior to the construction of the road pavement.

- **Existing tailings dams** For much of the route the N17 is in close proximity to the operational Mooifontein and Diepkloof tailings dams. The dams’ current heights are in the order of 30–40 m and their proposed final heights will be up to 60 m. The link road comes as close as 150 m to the toes of these dams and falls within the ‘zone of influence’ of the dams. A detailed analysis has been undertaken and the design of the dams gives no cause for concern, provided of course that the dams continue to be managed and operated to accepted norms and standards.

- **Contaminated soils and water** Testing on tailings, ground water and surface water show that all of these will be highly aggressive towards steel, concrete and cement (for example when used in stabilised layers) and several mitigating measures will be implemented. These include the use of high durability concrete for ‘very severe’ environmental exposure conditions as well as increased cover and smaller design crack widths. In addition, bituminous coatings will be applied to concrete exposed directly to tailings and a buffer layer will be provided between any tailings and stabilised pavement layers.

The N17 Link Road project has been selected as the part of the N17 that will best serve the demands of the 2010 FIFA World Cup, while improving access to Soweto. It presents numerous geotechnical and materials challenges which are rarely encountered on a single project over such a short length. The variability of geotechnical conditions and materials used has required a relatively flexible design which can be reviewed and adjusted as conditions present themselves during ongoing investigations and construction.
The mass stiffness of a residual dolomite profile

IN CENTURION, SOUTH OF PRETORIA, the Gautrain Rapid Rail Link will cross the residual dolomites of the Monte Christo, Lyttelton and Eccles formations on a series of viaducts supported on piers spaced generally at between 44 m and 56 m apart. The construction of the link has been entrusted by the Gauteng Provincial Government to a joint venture comprising Bouygues Public Works, Murray & Roberts and SPG. Africon has been commissioned as designer for the Viaduct section by the Civil Works Joint Venture.

The residual dolomitic soil profile typically comprises hill-wash and alluvium overlying chert gravels and boulders in a matrix of orange-brown silty clayey sand, dark grey wad with chert and clay overlying dolomite pinnacles. The dolomite bedrock typically classifies as extremely hard rock, with unconfined compressive strengths (UCS) of 300 MPa or more. The depth to bedrock is extremely variable with variations of 30 m or more encountered in some instances over distances of only 3 m during the ground investigation. The variability in bedrock depth is illustrated schematically in figure 1.

During the early stages of design of the viaducts, it was planned to found the piers on bedrock using large-diameter piles, for instance typically four to eight piles per pier. The ground investigation therefore focused on determining the depth of bedrock at the pile positions. It soon became apparent once information from the ground investigation started to become available, that the extremely irregular bedrock profile, in combination with the hardness of the rock, could result in severe difficulties during construction. It could be very difficult to socket a large number of large-diameter piles into a steeply sloping very hard rock dolomite face as illustrated in figure 1.

It was subsequently decided to investigate the possibility of founding the Gautrain viaducts in Centurion on alternative foundation types which do not require piling to bedrock. This meant that ‘floating’ foundations had to be investigated. Large spread footings (also referred to as rafts) and piled raft foundations were considered. At the outset of this phase in the design, the general consensus was that the mass stiffness of the residual dolomite profile was likely to be too low to provide suitable support to the viaduct foundations which had to comply with strict settlement tolerances. The scepticism regarding the stiffness of the residual dolomite profile stems mostly from a general impression that a residual dolomite profile contains a lot of wad and that wad is a soft and compressible material.

Table 1

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Minimum</th>
<th>Average</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/m, (oedometer) (MPa)</td>
<td>0,7</td>
<td>21</td>
<td>57</td>
</tr>
<tr>
<td>E (plate load) (MPa)</td>
<td>7,5</td>
<td>24</td>
<td>46</td>
</tr>
</tbody>
</table>
Available information on the stiffness of wad has up to the present nearly always been determined from plate load tests or oedometer testing. Typical stiffness values for wad, determined from plate load and oedometer tests, are presented in table 1 (Day 1981). Settlement calculations carried out on the proposed foundations using average stiffness values from table 1 provided unacceptable results. The typical total pier load of approximately 30 000 kN, acting on a raft foundation measuring 12 m x 12 m, produced a calculated settlement of 55 mm for a 30 m deep soil profile. Settlements associated with live loads did not comply with tolerances required for the Gautrain.

It was realised, however, that plate load tests are only able to test a small volume of material, and in carrying out such a test, the test position is usually selected to be free of large cobbles or boulders that might cause the plate to settle non-uniformly. A consequence of this is that the stiffness obtained may test softer than what the mass stiffness of the greater soil mass might have been. The mass stiffness of a residual dolomite profile could be significantly under-measured when using plate load tests because the profile typically contains a significant amount of gravels and boulders. Many of these could be in direct contact and, being stiffer, would end up supporting a large portion of the overall load imposed on the soil mass. As a consequence, the stiffer, more competent material ends up carrying most of the load, while little load is transferred to the softer, less competent material. Conventional settlement calculations also do not take into account that small strains act on by far the largest proportion of the soil mass supporting a foundation, ignoring the significantly higher small-strain stiffness compared to a plate load stiffness. This generally conservatively overestimates the settlement.

In order to directly determine the mass stiffness of the residual dolomite profile in situ, it was decided to carry out a series of large-scale surcharge trials. The trials were designed to induce stresses similar to those that would typically be imposed by an actual viaduct foundation. In addition, the soil profile had to be loaded to a significant depth to ensure that the softer, wad-rich material underlying the chert gravels was stressed sufficiently to cause it to deform to enable its stiffness to be measured. The depth to bedrock at the first test location was on average about 30 m. The loaded area therefore had to be large. In order to more fully understand the effectiveness of the full-scale loading, a surcharge trial was carried out using a contact stress of about 230 kPa applied over an area measuring 20 m x 20 m. The surcharge comprised 1 000 concrete blocks that were specially manufactured for this purpose. Each block consisted of 4 m^3 of concrete measuring 2 m x 2 m x 1 m and weighed about 9,6 tonnes. The stress distribution with depth below the surcharge centre, based on a Boussinesq stress distribution, is illustrated in figure 2.
Approximately 20% of the applied stress increase reached bedrock at about 30 m according to the theoretical stress distribution.

In addition to measuring the overall stiffness of the profile, it was important to measure the stiffness of the wad-rich material deeper down in the profile because thick wad profiles would potentially compress more than a profile with little wad. Two sets of multi-depth extensometers were therefore installed below the surcharged area to enable compression to be measured over various depth ranges. In order to have access to the extensometers, the surcharge was placed in quadrants as illustrated in figure 3. The extensometer anchors were installed to target the boundaries between different soil strata. Delineation of various strata in a residual dolomite profile is not an easy task, however, as a result of the extreme variability in material composition over short distances. In addition to the extensometers, surface settlement monitoring points were installed around and between the quadrants of the surcharge as illustrated in figure 3. These were monitored by means of precise levelling at regular time intervals during the placing of the surcharge and once the full surcharge had been placed.

The first surcharge trial was carried out at Pier 55 just south of Von Willich Street in Centurion. The surcharge was placed in layers using a large crane. To ensure that the surcharge area was loaded as uniformly as possible, each layer, comprising 100 blocks, was completed before starting with the next layer. The surface monitoring points were surveyed after completion of each layer. Figure 4 shows the completed surcharge with 1 000 blocks in position, exerting about 9 600 tonnes over a 20 m x 20 m area.

OBSERVED SETTLEMENT

The observed settlements were expected. As the surcharge grew, the monitored settlements were much smaller than predicted by historical approaches.

The settlement calculated based on soil stiffnesses originally assigned to the various materials comprising the profile amounted to 51 mm below the centre of the surcharge. After eight layers of blocks had been placed, the maximum recorded settlement amounted to only 25 mm. Large scatter was observed in the settlements recorded around the surcharge. Concern arose that the surface settlement points were not accurately reflecting the actual settlement of the blocks and it was decided to bolt settlement monitoring points directly to the base layer of blocks themselves (see figure 3). While loading the remaining two layers (layers 9 and 10), the blocks did settle significantly more than the immediately adjacent ground surface, indicating that the blocks tended to push into the ground. Monitoring points were attached to the base layer of blocks for all subsequent surcharge trials. This enabled the settlement of the blocks to be compared to the surface settlement during the placement of layers 2 to 10. In later pier foundation surcharging, it was decided to omit the surface settlement points and only use monitoring points on the blocks themselves.

The block settlement tended to exceed the surface settlement, especially along the perimeter of the surcharge. The difference was found to be small near the centre of the surcharge. Explanations related to the yielding of soil near the edges were proposed to explain this, but the fact that block and surface settlement correlated relatively well near the centre of the surcharge indicated that the most realistic stiffness estimates would be obtained from settlement points near the centre.

By the end of February 2008, a total of ten surcharge trials have been carried out. A few typical results are presented.

Owing to site constraints, only the first two test sites were instrumented with multi-depth extensometers. The extensometer measurements indicated that by far the greatest proportion of movement occurred within 4 m from the surface in what was thought to be the stiff chert gravels. The wad-rich part of the profile compressed little and back-calculated stiffnesses from the extensometer data were unexpectedly high.
Figure 5a presents the block settlements monitored at the Pier 55 surcharge trial. Figure 5b shows the stiffnesses calculated from these settlements. The stiffnesses were calculated from the average stress increase associated with the placement of surcharge layers 1 to 10 in the case of the surface settlement points and from the stress increase associated with the placement of layers 2 to 10 in the case of settlement points on the blocks. The average stress increase was determined assuming a Boussinesq stress distribution with depth and an average strain calculated from the settlement over the depth to bedrock. Boussinesq is of course an approximation in a non-homogeneous soil. The depth to bedrock was estimated as well as possible from available site investigation data. Stiffnesses varied greatly over the footprint of the surcharge area and also from surcharge area to surcharge area. The results were often surprising, with areas that were thought to be soft (due to the perceived occurrence of wad-rich soil profiles interpreted from rotary percussion borehole logs) compressing very little and vice versa. Stiffnesses were, however, generally significantly higher than those assigned based on plate load tests, indicating the benefits of taking into account the much higher small strain stiffness of the profile.

**TIME RATE OF SETTLEMENT**

The settlements were observed to stabilise rapidly after placing of the surcharge. In nearly all cases, movements had practically stopped after a week of the full surcharge load being placed. The high permeabilities, typical of a residual dolomite profile, would have meant that consolidation (if any) would have been completed rapidly for those cases where the water table is located above bedrock level and within the influence zone of the surcharge load. Time-dependent movements in such a profile (if any) would therefore be attributed to creep effects. In a few cases where the opportunity occurred to leave the surcharge in place for some time, maximum creep movements of approximately 1 mm per month were observed, which appeared to be reduced even further with time.

**CONCLUSIONS**

Significantly higher mass stiffnesses were back-calculated from the surcharge settlements than originally predicted based upon conventional accepted approaches. This indicates that the much higher small-strain stiffness of the profile should be considered in settlement calculations. An important consequence of the surcharge trials and subsequent production surcharging of pier foundation locations was that the stiffnesses applied in the design could be increased significantly, resulting in less conservative and more cost-effective designs.

An additional benefit of the pier foundation surcharging is that the surcharge acts as preloading over the foundation footprint area. Upon unloading generally only about one fifth to one third of settlement was recovered, suggesting that the surcharging increases mass stiffnesses significantly.

The full-scale surcharge trials resulted in an improved understanding into the behaviour of residual dolomite profiles in terms of how they respond to large foundation loads. These trials are a good example of how close collaboration between a consultant and a client, prepared to make an investment in ambitious site investigation techniques, can lead to more appropriate and optimised engineering solutions.

**Acknowledgement**

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**Reference**

AFTER A RELATIVELY QUIET PERIOD, southern Africa is now in the thick of a period of intense tunnelling activity. This has been the consequence of the urgent need for more power at peak periods, the start of a major railway project, and the ever-increasing need for water in Gauteng. While this state of affairs is to be welcomed, the country’s construction resources are being severely stretched to meet these needs.

The 1332 MW Ingula (Braamhoek) Pumped Storage Scheme is now well under way. The exploratory tunnel is being extended into the area of the powerhouse, and construction of the main access tunnel began in the last quarter of 2007. Construction of the main underground works is expected to commence in the near future. Planning on a larger but similar project north of Middelburg is well advanced.

Tunnelling for the 15 km underground section of Gautrain between Park Station and Malboro is progressing on 12 work fronts. About 3 km of the route has been excavated, which includes just over 100 m of tunnel being bored by the largest TBM used in southern Africa to date. The earth pressure balance TBM bores a 6,46 m diameter tunnel which is lined with a precast segmental lining 300 mm thick.

The prospects for ongoing tunnelling work look good – but there is a chronic shortage of tunnellers in South Africa. Recruitment overseas is difficult, however, as the shortage is being experienced worldwide.
THE MKOMAAS RIVER PEDESTRIAN BRIDGE that was recently constructed in the Mkomaas Valley, in a remote part of KwaZulu-Natal, is the first prestressed ribbon bridge in Africa. The clear span of 150 m equals the world record for this type of bridge.

The bridge won three major engineering awards for its designer, Corrie Meintjes, of Jeffares & Green consulting engineers.

The unique bridge design and remote site location tested the ingenuity of everybody involved in the project and Terratest, the geotechnical, environmental and earth science consultancy, were tasked with finding geotechnical solutions for the large tensile forces acting at each abutment.

For this bridge the maximum force, as a working dead load, is about 7 500 kN, acting along the axis of the stressed cables. These are at about 8° below the horizontal, which results in a very large horizontal component and a small vertical component. Options available to generate the required horizontal resistance include mass concrete anchor blocks, raking piles and rock anchors.

Terratest’s Deneys Schreiner analysed several options and concluded that rock anchors would be the better solution, both technically and economically.

GROUND CONDITIONS
The ground profile at the bridge site is about 9 m of loose to medium dense alluvial sand with numerous small to large hard rock boulders overlying Charnockite which is slightly weathered to unweathered hard rock. Mass concrete anchor blocks in the soil were found to be very expensive. Raked piles were considered unsuitable due to the boulders and to the difficulty of drilling a sound rock socket. Drilled and grouted anchors were chosen as a viable and cost-effective solution.

ROCK ANCHORS
Typical anchor design working loads were in the region of 2 500 kN under peak live and dead loading. Three pairs of anchors were used at each abutment with the rake and splay set to give the required resistance together with lateral stability and sufficient spacing between the grouted sections. The anchors nearest to the river were spayed outwards at 45° and raked away from the river at 55° degrees to the vertical. The second and third pairs had zero splay and were raked at 60° and 65° respectively. Terratest designed the anchors to carry most of the horizontal loading with the soil beneath the abutment carrying the remainder in shear against the concrete underside of the abutment.

The 250 mm diameter anchors were installed by Esor with about 9 m of free length and 9 m of grouted length. Drilling through the alluvial soils and boulders proved difficult but was ultimately achieved successfully. Twelve anchors were installed into the Charnockite and tested in pairs to 2 600 kN load per anchor. During the load testing the vertical and horizontal movements of the abutments were monitored using surveying for the vertical movements and by laser distance measurements for the horizontal movements. The expected movements due to compression and shear strain in the alluvial soils had been estimated by Terratest prior to the testing and the observed movements were compared with the observations during the load testing. The expected movements were up to 70 mm under the maximum loading conditions.

In general the movements were within expected ranges. During the testing of the pair of anchors closest to the river on
the north abutment the settlements were noted to be larger than expected. Loading of these anchors without the remaining four anchors being stressed puts a large eccentricity on the abutment which causes high stresses in the soils at the river end of the foundation. The loading of this pair of anchors was therefore stopped temporarily while the middle pair of anchors was tested to full load and then locked off at about 50% of the working load to reduce the eccentricity. This was successfully completed with acceptable settlements. The test loading of the anchors near the river was then completed without excessive movements.

**PREDICTED PERFORMANCE**

The performance of the abutments and the ground anchors was predicted by Terratest prior to the commencement of construction. Owing to the relatively soft foundation stiffness the expected movements were large, both vertically and horizontally. The eccentricity of loading led to the predicted movement of the river end of the abutment being downward and towards the river while the land side end of the abutment was predicted to move very little downwards. The horizontal movement at the land side was, of course, the same as for the river end of the abutment. The different directions of movement led to different load responses in the anchors as the downward movement effectively reduces the tension in the anchor strands. If all of the anchors were initially assumed to be at zero load, then the land side anchors were predicted to pick up considerably more load than the river end anchors. This could lead to the land side...
anchors being overstressed before the full working load was applied to the abutment. In order to achieve a relatively uniform loading on the three pairs of anchors the initial load on the river end pair was set to the highest preload and the land side pair were set at the lowest preload.

**PERFORMANCE MONITORING**

The performance of the anchors was monitored during construction to ensure that the predictions regarding the loading were met. Allowance was made in the design of the anchor heads for the loads to be adjusted if necessary by the removal or addition of shims. These were installed in varying thicknesses as pairs of half anulii to give a maximum possible removal of 50 mm of shims. This corresponded to about half of the elastic extension of the tendons and thus about half of the design load. The performance could be measured by monitoring the movement of the abutment but this would then only allow indirect estimation of the loading in the anchors.

**ANCHOR LOAD MEASUREMENT**

Load cells were therefore designed and fabricated by R Bodger and B D J Schreiner of the Department of Mechanical Engineering at the University of KwaZulu-Natal and installed under each anchor head. Owing to the severe conditions expected on the construction site and the desire to have load cells that would remain stable over the lifetime of the bridge, the load cells were designed without sensitive internal sensors such as strain gauges. Instead, use was made of ‘smart steel’ which changes its magnetic properties with strain. These steels are initially non-magnetic and become progressively more magnetic with increasing plastic strain. The load cell output reflects the maximum past loading and not the current loading. These properties are useful in designing a load cell which will theoretically record the maximum strain and thus load which has been applied at any point in time. It is thus not necessary to measure the load during a severe wind event as the load cell will record the maximum conditions reached.

The magnetic properties are measured with a hand held, digital inductance meter which measures the inductance of a copper wire coil around a ‘smart steel’ core within the load cell. The changes in the magnetic properties of the ‘smart steel’ result in changes to the inductance of the coil. The meter is plugged into a simple two-wire ‘jack plug’ in each load cell in turn and is taken off site after the readings are made. The plug points were protected inside a 5 mm thick steel box with a bolted cover. Two meters were used to check the repeatability of the results and to have a backup in case one of the meters was damaged or lost. Figure 1 shows a load cell, painted red-brown, installed below the anchor head in an anchor with the two digital meters visible.

**ACTUAL PERFORMANCE**

The loads measured in the anchors are shown in figure 2 for three of the anchors on the south bank, SB. These are the riverside (RS), middle (M) and landside (LS) on the downstream (DS) side of the abutment. It is of interest that the anchor loads did not change much from the preloads until a deck tension of about 4 000 kN was reached. This is inferred to be the resistance provided by the colluvial soils acting against the underside of the large, cast-in-situ abutments. Some of the resistance is due to the deadweight of the abutments and but most is due to the vertical component of the anchor loads.

Figure 3 shows the inferred resistance calculated as the sum of the available soil resistance plus the horizontal component of the measured anchor loads. The soil resistance is mobilised progressively as the deck tension increases until the movement of the abutment became sufficient to begin mobilising the resistance of the anchors. Thereafter the anchors carry an increasing percentage of the horizontal load.

**CONCLUSION**

The monitoring of the loads in the high-capacity anchors during the construction and stressing of the bridge deck has been instrumental in confirming both the design assumptions made by Terratest and the performance of the foundation system as installed by Esor.
Thinking laterally

Esor in Sandton

CIVIL AND GEOTECHNICAL ENGINEERING contractor Esor is prominent in the Sandton CBD with the construction of lateral support for some key projects, one of which is located only 20 m from the Gautrain station.

The largest of the contracts is No 1 Station Place on the corner of West Street and Rivonia Road, which is being constructed for Savannah Group Properties and will house a shopping complex and a hotel, with copious basement parking. The 2 600 m$^2$ of lateral support called for 96 perimeter piles to be installed in 3 m lifts to a height of 11 m, with reinforced arches linking the piles and the whole covered in Shotcrete. Over 360 post-tensioned round anchors have been provided, as well as some 300 soil nails.

With blasting for the Gautrain tunnel and station taking place within 20 m of the piling operation, longer than normal anchors had to be used, says contracts manager Gideon Lesia. Potential effects of blasting are monitored twice a week to ensure that any impact is detected and dealt with in good time.

Additional challenges have included a dyke flowing through the site and the loss of 25 working days because of the heavy rains in January. ‘Those days were not entirely written off as we could continue with drilling and grouting,’ explains Lesia. ‘We are making up for lost time with evening and week-end overtime. Due to the number of residential properties on the border of this project, however, overtime hours are limited in order to reduce the nuisance of high noise levels.’

The second contract, Legacy Corner, on the corner of Fifth and Maude streets, which involves 1 280 m$^2$ of lateral support, provided its own challenges, he says. Rock was encountered no more than a metre below the surface and a large quantity of material had to be blasted, without damaging the electrical, storm water and sewer services running through the site. Legacy Corner will be another hotel for the Legacy Group, owners of the nearby Michelangelo Hotel.

No 9 Fredman Drive, on the corner of Bute Street, called for the installation of 4 600 m$^2$ of lateral support. Here there were no piles, but a permanent wall in two layers with drainage provided behind every wall to ensure no seepage into the construction. The site is being developed as an office block by Rand Merchant Bank Properties.

Additional projects under Lesia’s management also include another lateral support installation in Sandton at 3 Gwen Lane, directly opposite the studios of Radio 702 and 94.7 Highveld Stereo; lateral support at the Randburg headquarters of Multichoice; and a 270 m long pipejacking project at the Moreleta Spruit in Pretoria, to install a 1 473 m diameter sewer line crossing two rivers and passing beneath five blocks of flats.
FRANKI AFRICA has been busy on several lateral support contracts in the Western Cape. These include three challenging contracts for ‘spec’ builders in Bakoven, Camps Bay and on the Atlantic seaboard of Cape Town, and another contract in Somerset Road, Green Point.

The Green Point contract, a Phase 2 design and construct contract to carry out lateral support for the construction of a five-storey underground car park basement on Somerset Road, was awarded in May 2007.

The contract followed construction of a two-storey basement on the adjacent block, known as Cape Quarter, a multi-use development of restaurants, retail and offices situated conveniently close to the 2010 FIFA World Cup stadium currently under construction.

Franki has carried out numerous similar projects in this area including the Rockwell basement, 12,0 m deep, directly across Somerset Road from the Cape Quarter 2 site. The Cape Quarter basement has a footprint of approximately 6 400 m$^2$ and falls in depth from 13,0 m deep to 9,0 m deep on Somerset Road.

The area soil profile consists of shales, greywacke, and siltstones of the Malmesbury group, developing with depth from highly weathered silty shales to hard rock ‘blue Malmesbury’. The hard rock can be found in ridges and valleys/gullies of weathered or soft rock in which ground water running off Signal Hill can be found.

Lateral support methodology for shallow and deep basements in this area has been based on a Geonails and gunite wall construction with soldier piles socketed 1,0 m to 2,0 m deep into hard rock through soft/weathered shale. Demolition of the existing buildings started in May this year, with the historical ‘E K Green’ façade and warehouse buildings to be maintained along Somerset Road. Soldier pile installation along the basement perimeter overlapped with demolition at the beginning of June. The soldier piles involved rotary percussion (DTH) piles 165 mm in diameter and at 1,5 m c/c. For this Franki utilised the Casagrande C9 drill rig, which proved more than adequate for the task, achieving on average 12 piles per day (12,0 m long).

The tight six-month construction programme meant that excavation for nailing and guniting followed very closely behind. For the approximately 2 800 m$^2$ of lateral support face Franki’s new Casagrande C4 drill rig was used along with the new MAT grout mixer and high pressure pump that was used to install the top 15,0 m long 30/11 Titan anchors along the Jarvis Street face, with the lower rows consisting of 25 mm gewi bar Geonails ranging from 9,0 m to 4,0 m long.

The collapse of one of the warehouses on the façade while structural modifications were being carried out highlighted the need to shore and prop façades previously considered secure. This resulted in a change of excavation sequence and partial handover of half the basement to the main contractor at an earlier date. A three to four week delay had to be accommodated in the programme while the building was being made safe and investigations into the collapse were being completed.

Franki Cape Town’s Marcel Hoffman reports that this contract was completed in February 2008 on time and that construction is well under way. ‘Half of the basement area is already up to the third deck level and bases on the other half will be completed by the end of March 2008,’ he says.

He adds that lateral support movements recorded in the monitoring process shows that stability of all faces has been achieved since completion within the predicted tolerances. ‘The monitoring will continue until the propping slabs are completed up to ground floor level.’
The other three ‘spec’ builder projects included work at Bakoven where Franki’s long-term presence finally came to an end with the completion of the last contract there in December 2007.

Bakoven is an area with its own particular bag of geological ‘nasties’ – a lot of ‘hill wash’ material, silty sands with pebbles, cobbles and boulders of anywhere between 1.0 m diameter and 5.0 m diameter. Beneath this is some fairly nice-to-work, weather granite material in which can be found large to ‘extra large’ fresh granite boulders, often in the most unlikely and unwanted areas of excavation and sometimes requiring ‘rolling’, ‘splitting and anchoring’ or simply ‘blasting’.

All three ‘spec’ builder contracts shared the same problems with boulders and ground water/rivers, which have never stopped flowing with the particularly wet winter and early summer rain that the Cape experienced in 2007.

Hoffman reports that construction is well under way on all three developments with some other sites in the Atlantic seaboard area up for auction.

'We expect more work from this area in the near future. In fact we have recently quoted on a R6 million basement in Camps Bay, which we will probably start working on in the next couple of months,' he concluded.
About the Geotechnical Division

THE GEOTECHNICAL DIVISION of the South African Institution of Civil Engineering (SAICE) is a technical sub-committee for professionals active in geotechnical engineering. The division has a committee consisting of volunteers that represent and promote the interest of its members. The division is affiliated to the ISSMGE (International Society of Soil Mechanics and Geotechnical Engineering) and currently has some 280 members.

The purpose of the Geotechnical Division is to provide a platform for the development of the geotechnical engineering industry and to develop a network of communication and skills translation within the industry.

Current activities of the Geotechnical Division include the following.

CPD-ACCREDITED EVENING LECTURES
A number of interesting and relevant evening lectures are held annually to promote continual professional development within the geotechnical engineering industry. Topics are varied to cover all facets of geotechnical engineering with the focus on providing attendees with interesting background information on topics rather than in depth technical details. All evening lectures are CPD accredited.

INVolvEMENT IN GUIDELINES AND CODES OF PRACTICE
The Geotechnical Division has been involved with a number of codes of practice and best practice guidelines within the industry. The recent launch of the Code of Practice for the safety of persons working in small diameter shafts and test pits for geotechnical engineering purposes (developed in conjunction with SAIEG) sets an example for other industries in their commitment to keeping up with current occupational safety legislation. The division is currently involved with the compilation of a site investigation guideline for best practice as well as the geotechnical aspects of the new loading code currently under revision. All of this is done with the input of expert professionals within the various fields to ensure that codes are technically accurate and relevant.

CONFERENCES AND SEMINARS
South Africa is well known internationally for its expertise within the geotechnical engineering industry. Conferences and seminars organised through the Geotechnical Division provide a platform for sharing this knowledge with fellow engineers, thereby ensuring the constant advance of the industry. This year the division has planned the 2008 Young Geotechnical Engineers Conference which will focus on candidates younger than 35 years of age, as well as our flagship event for 2008 – the Conference on Problem Soils in South Africa.

COMMUNICATION WITH MEMBERS
Good communication of events forms the basis of networking and continued professional development within the industry. The Geotechnical Division has developed a website where members as well as other interested persons can register to receive e-mails on events planned. The website also provides more information on events, awards, publications, etc. A database of members is also available.

In addition, the April issue of Civil Engineering magazine focuses on geotechnical engineering and is therefore aimed at communicating interesting projects, new developments and upcoming events to the engineering community.

RECOGNITION TO LEADERS WITHIN THE INDUSTRY
The strength and successes of the geotechnical engineering industry in South Africa would not have been what it is today if not for men and women that took the effort and courage to step up to the plate. Recognition is given to these leaders in our industry through various awards. In 2007 the following awards have been made at the AGM of the Geotechnical Division:

- Bernie Krone was awarded the Geotechnical Gold Medal. This award is given to persons that through their career has made a significant contribution to the development of the industry
- Professor Geoff Blight received the Jennings Award for the best paper in 2007 for his paper on ‘Opportunities, chal-

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<td>Site investigation best practice guidelines</td>
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<td>Geotechnical engineering issue of Civil Engineering</td>
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<td>Advanced PLAXIS course</td>
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Dates and venues of certain events to be confirmed. Please consult website for more detailed information

Please contact SAICE to become a member of the Geotechnical Division. To receive information on events, please register on our website: www.geotechnicaldivision.co.za
THE GEOTECHNICAL DIVISION wishes to invite nominations for the following awards for 2008.

**Jennings Award**
The Jennings Award is presented annually to the author(s) of a paper on a geotechnical subject published at a local or international conference or in a journal. The award is made in honour of Professor J E Jennings, who is widely regarded as the pioneer of modern soil mechanics in South Africa.

**Barry van Wyk Award**
This award is presented annually to a final-year student at a South African university or technicon for his/her final-year dissertation which must be in the field of soil mechanics or geotechnical engineering.

**Gold Medal Award in Geotechnical Engineering**
The gold medal award is presented to a person that has made a significant contribution to furthering the art and science of geotechnical engineering in South Africa through his/her career.

**Fellowship of SAICE**
Fellowship of SAICE is awarded to members of SAICE that have inspired and motivated others within the industry through their dedication and contribution towards the civil engineering industry in South Africa. Nominations forwarded to the Geotechnical Division will be specifically for persons working within the field of geotechnical engineering. Awarding of fellowships will be at the discretion of SAICE.

Nominations, accompanied by a copy of the relevant paper, dissertation and/or motivation should be mailed to:
Solly Phalanndwa
Franki Africa
PO Box 39075
Bramley
2018
E-mail: sollyp@jhb.franki.co.za

The deadline for submissions is 31 June 2008. The presentation of the awards will take place at the Geotechnical Division’s annual general meeting to be held in November 2008.
Young Geotechnical Engineers Conferences

THE GEOTECHNICAL DIVISION of SAICE hosts a Young Geotechnical Engineering Conference (YGEC) about every three years. The conference aims to attract young geotechnical and environmental engineers, as well as engineering geologists and geologists.

‘Young’ is defined as 35 years of age and younger at the time of submitting an abstract. The conference aims at providing a platform for young geotechnical practitioners to share their knowledge and experience in an informal and friendly environment. The conferences are organised at exciting venues which provide opportunities for interaction between delegates between and after conference sessions.

SOUTH AFRICAN AND AFRICAN
YOUNG GEOTECHNICAL ENGINEERING CONFERENCES

The first South African Young Geotechnical Engineers Conference took place in 1990. These conferences usually have a theme that is aimed at promoting a particular aspect of geotechnical engineering. The theme does not restrict the content of the papers, but merely acts as a guideline for prospective authors.

The conference organising committee invites a ‘godfather’ figure from the fraternity of senior South African geotechnical engineers. His duties are to formally open and close the proceedings, to give feedback on the paper presentations and to select the best paper and presentation delivered at the conference. Traditionally, the author of the best paper and the best presenter are sponsored by SAICE’s Geotechnical Division to attend the next International YGEC.

To date, six YGECs were held on the continent of Africa, two of which outside the borders of South Africa. Some of them were:

2003 First African Young Geotechnical Engineers Conference
Conference venue National Marine Aquarium, Swakopmund, Namibia
Theme Mining and Geotechnics – Foundation for an African Tomorrow
Godfather Peter Day
Technical tour Rössing Uranium Mine
Best paper Julian Venter
Number of papers 39, of which 21 % were from other African countries

2003 Young Geotechnical Engineers Conference
Conference venue Swadini Aventura resort
Theme Environmental Geotechnology
Godfather Alan Parrock

2007 2nd African Young Geotechnical Engineers Conference
Conference venue Yasmine Hammamet (Tunisia)
Technical tour Radès-La Goulette Bridge
Number of papers 36 from seven countries
The conference was attended by three young engineers from South Africa

INTERNATIONAL YOUNG
GEOTECHNICAL ENGINEERING CONFERENCES

International Young Geotechnical Engineer Conferences (iYGECs) are held under the auspices of the International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE). The first such conference took place in Southampton, United Kingdom, in 2000 and was aimed at promoting the development of future geotechnical engineers and to encourage international exchanges between them. The event was sponsored by the British Geotechnical Association and the ISSMGE. It was fitting that this event was held in the UK where the concept of Young Geotechnical Engineers Conferences originated with Professor John Atkinson at London’s City University in 1981. Several regional YGECs have since been organised by ISSMGE member societies.

The second iYGEC took place in Mamaia, Romania, in 2003 and the third in Osaka, Japan, during the ISSMGE International Conference in September 2005. This conference was sponsored by the ISSMGE and the Japanese Geotechnical Society. The 88 attendees at the iYGEC were chosen from 45 countries with usually two delegates coming from each country. The next (4th) iYGEC will take place in Alexandria (Egypt) from 5 to 9 October 2009 and will be held in parallel with the next ISSMGE International Conference.

NEXT YOUNG GEOTECHNICAL ENGINEERS CONFERENCE

The next YGEC will be held in Durban at the Camelot Conference Centre (Greensleeves) from 20 to 22 August 2008. The theme of the conference will be ‘Geotechnics – 2010 and Beyond’ and it is aimed at addressing the issues surrounding the FIFA World Cup, harbour developments and the Gautrain project. The ‘godfather’ of this conference will be Bernie Krone of Esor. Interested young engineers are invited to submit a paper to be part of this conference. Please contact Lesley Stephenson for more information at lstephenson@mweb.co.za.
GEOCOMPACTION DYNAMICS is a fitting name for a small company which, after barely six years in existence, has already established a firm niche for itself in the specialist geotechnical contracting market.

Founder and managing director Eben Blom says that when he started the company in 2002, he did not fully anticipate that the economy would grow at such a brisk rate and that the demand for geotechnical expertise would be increasing accordingly. The number and size of contracts successfully completed to date have exceeded his initial expectations. His upbeat view of the future encompasses being involved on contracts such as the Gauteng Freeway Improvement Project and the upgrading of Oliver Tambo International Airport, as well as some more large private development projects.

FURSTENBURG GRAND
GeoCompaction Dynamics’ biggest project to date has been the construction of the lateral support for a new apartment development, named Furstenburg Grand, in East London. ‘In last year we were invited to submit a quote for this contract on the basis of our experience gained over the years in hollow bar and anchor installations,’ he says.

‘The developer had bought the old Dolphin Hotel on Beach Road in the suburb of Nahoon, and had demolished the structure to make way for new up-market apartments with a spectacular view over the Eastern Cape coastline.’

The new structure was to consist of two basement levels for parking and four levels providing luxury accommodation. ‘With neighbouring properties that had been developed 2 to 3 m from the boundary line, as well as the need to develop the entire stand area, lateral support was required to construct temporary vertical retaining walls,’ says Eben.

NEW APPROACH
‘The site was underlain by deep deposits of windblown Aeolian dune sands, and we therefore adopted, what we think, is a revolutionary design to save the client both time and costs. Since the conventional lateral support design using perimeter piled walls and anchors proved too expensive in this situation, we adopted a new design and construction approach,’ Eben explains.

‘Our design consisted of hollow bar soil nails drilled to a maximum depth of 10 m into the vertical excavation, and a 100 mm reinforced gunite face to retain the wind-blown sands. We also needed to supply additional support along the boundary wall with The Reef holiday apartments, as the development was constructed on spread footings and located only 3 m from the proposed vertical excavation. We therefore used 450 kN temporary anchors to restrict, or minimise, any lateral movement along the boundary wall.’

GeoCompaction Dynamics’ design and construct was adopted by the client, and the contract could commence on time.

HOLLOW BAR SYSTEM
‘In excavating the 1.5 m lifts, the hollow bar nails were drilled and installed into the loose sands and gunite applied to secure the excavation,’ says Eben.

‘The hollow bar system is normally used in a very loose soil type where the conventionally drilled holes tend to collapse before the nail can be installed. The hollow bar nail is used as the drill string, and a disposable bit is fixed to the front of the nail. The nail is then fixed to the head of the drilling machine and grout is pumped through the hollow bar system during the drilling operation.’

Once the first lift had been secured, the process was repeated for the excavation of the second lift, until the final excavation level was reached. A vertical excavation of 8 m was completed some two months after the start of the contract, allowing the main contractor to commence with the civil works.

OTHER MAJOR PROJECTS
■ Similar in design to the Furstenburg contract, lateral support work was
done at the Beacon House in Knysna.
This prime development, located at The Heads in Knysna, consists of a three-storey apartment complex. Here, a 13 m high vertical face had to be supported before construction on the private development could commence.

- At Hatfield Gardens in Pretoria, a 7 m deep basement was excavated to accommodate an office park.
- Work is currently in progress on the Atterbury/R21 interchange, where the N1 needs to be widened as part of a programme by the South African National Roads Agency to upgrade the country’s road network, especially in fast-growing urban areas.

At Victoria Bay, GeoCompaction Dynamics installed 250 m diameter percussion piles for the abutments of a bridge forming part of the rehabilitation of the railway line carrying the well-known Outeniqua Choo Choo train between George and Knysna. The piles were socketed into solid rock, preventing any possible movement of the railway line. The project was completed on schedule and in time for the train to be operational before the peak holiday season.

Temporary lateral support was required during the construction of the Furstenburg Grand apartment complex in Nahoon, East London. The structure and basement were positioned to within 3 m of the boundary wall and the excavation could therefore not be battered back. GeoCompaction Dynamics constructed a temporary lateral support wall so that the conventional foundations at the toe of the excavation could be safely constructed. Temporary soil nails and a coat of reinforced gunite were applied to secure the wall.

Eben Blom, founder and managing director of GeoCompaction Dynamics.

Beacon House, The Heads, Knysna.
Engabe bantfu babutsatsa njani bunjinelwa?


S I S W A T I  F E A T U R E

Ngekubuka kwami kungenteka kwekutsi simo

This problem is more common in rural schools, where information is not so readily available. Having grown up in a rural area, I have also had a hard time trying to explain to my parents and our neighbours what I do as an engineer. My daughter, who is now 14 years old, was given an assignment to write about her family while she was still in primary school. When she reached the part about her parents’ jobs she wrote: ‘My father works for Water Services. He is a motor car driver.’ (I was then working for Swaziland Water Services as a water distribution engineer and I was allowed the use of a company vehicle after hours …)

We as engineers need to open up to people so that they can understand our chosen career and appreciate the kind of work that we do. We should volunteer more often to take part in school career days. We should help students in weekend revision classes to help them boost their mathematics and science grades. The same media used for entertainment can be used to educate the youth about engineering careers.
Experts recently redefined it. International scientists, including some at Sandia National Laboratories, agree that it’s time to redefine it.

Three electricity experts from Electricité de France (EDF) arrived in South Africa to work with Eskom to define the country’s most pressing needs in terms of power generation capacity maintenance. The focus of their fact-finding mission is the de-mothballing of coal power plants, as well as the assessment and provision of the technical skills needed.

Following the results of their appraisal, more experts from Electricité de France will visit South Africa to assist their South African counterparts.

French company Alstom also sent four technicians to South Africa last week to investigate the maintenance of boilers and turbines at South Africa’s power plants. Alstom has just signed a R13 billion contract with Eskom to provide steam turbines for the construction of new coal power plants.

Twenty-five technicians from nuclear power company Areva are also in the country, working with Eskom to increase the generation capacity of the Koeberg nuclear reactor.

Scientists are hoping to redefine the kilogram by basing it on standards of universal constants rather than on an artifact standard.

The International Prototype Kilogram (IPK) or ‘Le Grand K’, made in the 1880s, is a bar of platinum-iridium alloy kept in a vault near Paris. ‘The idea is to replace the single master kilogram with something based on physical constants, rather than an artifact that could be damaged accidentally,’ says mechanical engineer Hy Tran, a project leader at the Primary Standards Laboratory (PSL) at Sandia.

Sandia is a National Nuclear Security Administration laboratory.

Of the seven units of measurement in the International System, or SI, the kilogram is the only base still defined by a physical object. In addition, copies of the kilogram have changed over time by either gaining or losing weight as compared to the standard kilogram.

The purpose of redefining the kilogram is based on risk reduction, says Tran. ‘In the long term, the redefinition – especially if performed correctly – is beneficial because of risk reduction and because it may enable better measurements in the future,’ he says.

By replacing the master kilogram – Le Grand K – with a unit based on physical constants, researchers at multiple laboratories and at national measurement institutes could establish traceability, he says.

Tran says the kilogram will remain the kilogram; it’s only the way it will be defined that will change. He says the earliest the kilogram would be redefined is 2011.

‘If and when the redefinition takes place, it will be done in such a fashion as to have minimal or no practical impact with other measured quantities,’ Tran says. ‘In other words, if it is redefined so as to ensure better than 10 parts per billion agreement – rather than 20 parts per billion agreement – then we will see no major changes immediately.’

Based on the current formal definition of the kilogram (the mass of the 1 kilogram prototype) and experimental dissemination to standards labs, the uncertainty (95 % confidence) in PSL’s kilogram is about 40 parts per billion, compared to the IPK.

One part per billion is about the ratio of the area of a square 3 inch on a side, with respect to the area of a regulation NFL football field (including the end zones, or 120 yards by 531 yards), Tran says.

The target originally proposed by the Bureau International des Poids et Mesures (International Bureau of Weights and Measures) was to get one of the alternative kilogram definitions, such as the experimental measurement of force on the watt balance (or counting atoms on the silicon sphere), and deriving the kilogram, matched to experimental measurements of the prototype kilogram to within 20 parts per billion.

Sandia physicist Harold Parks agrees that the redefinition of the kilogram is inevitable and says there are a couple of issues that need to be resolved before it’s redefined.

‘The watt balance method of defining the kilogram makes the most sense for those of us in electrical metrology and so far it is the most accurate,’ he says. ‘But other proposals, such as those based on counting the number of atoms in a silicon crystal, are being considered.’

The watt balance is based on an idea that compares electrical and mechanical power with a high degree of accuracy, he says.

Conflicts between the results of the watt balance and the atom counting experiments will also need to be resolved, Parks says.

‘The NIST (National Institute of Standards and Technology) watt balance experiment has achieved the accuracy needed to redefine the kilogram, but the experiment will need to be confirmed by other groups in order for the results to be fully accepted,’ he says.

Tran says redefining the kilogram will have little impact on the Primary Standards Lab or the broader nuclear weapons complex. The lab develops and maintains primary standards traceable to national standards and calibrates and certifies customer reference standards.

‘It should not affect PSL or the complex if the international metrology community ensures that they fully consider the uncertainties, the necessary experimental apparatus to realise the kilogram, and implementation issues prior to agreeing to the redefinition,’ Tran says.

In preparation for the change, PSL staff members are staying up to date in research in metrology and standards practices. Staff also participate in standards activities in order to ensure that any transition would be smooth.
LOOK – NO CABLES!

DYNAMIC LOAD TESTING of Deep Foundations no longer requires cables to connect the sensors that acquire data for the test to a pile driving analyser (PDA). Pile Dynamics, Inc has released the wireless sensors the industry had been clamouring for. This development eliminates the need to transport heavy cables to the job site, simplifies the set up of the test, and allows the PDA to be placed at a considerable distance from the foundation being tested.

Dynamic load testing continues to be a reliable and cost-effective way of determining foundation-bearing capacity and investigating foundation integrity. In the case of driven piles, when the PDA also monitors driving stresses and hammer performance during driving, wire-

WYLIE’S POORT ROCK FALL PROTECTION STRUCTURES

AS PART OF SANRAL’S geotechnical improvements to the Wylie’s Poort cuttings on the N1 south of Musina, three new structural steel rock debris screens to the tunnel portals and a new earth-covered reinforced concrete rock fall shelter at Tunnel 1 were retrofitted to protect motorists from unexpected rockfalls.

The steel arch structures, designed by Vela VKE Cape Town, illustrate the innovative design and use of steel in a rock fall protection structure as well as the unobtrusive aesthetic appearance achieved using arched tubular members.

The screens are designed to withstand rock falls as well as vehicle impact loads. Best practice for rock impact design was used, with reference to Chapman’s Peak and Kovyn’s Pass rock fall shelters.

The design rock falls for these debris screens have a relatively low energy when compared with other rock fall protection structures. These debris screens have a design rock fall energy of just 35 kJ, whereas the reinforced concrete rock fall shelter at Tunnel 1 in Wylie’s Poort has a design rock fall of 3 000 kJ and the rock fall structures on Chapman’s Peak Drive were designed for a rock fall of some 5 900 kJ.

The design required the kinetic energy of the design rock fall impulse load to be absorbed within the elastic range of the members. Larger rock falls can safely be resisted by the debris screens at the ultimate limit state. The screen structures therefore catch and deflect smaller rocks with no structural damage. Larger rock falls will cause deformation, but not
In collaboration with the client, aesthetic appearance was given a high priority to allow the structures to blend into the scenically beautiful environment of Wylie’s Poort. To minimise the visual impact, a steel tubular structure that follows the curve of the arch of the tunnel and which is as small as possible was used.

The project also included a much larger earth-covered reinforced concrete rock fall shelter at Tunnel 1.

INFO

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CEMENT & CONCRETE INSTITUTE NOW HAS 11 ASSOCIATE MEMBERS

TEREX AFRICA, distributors of a comprehensive range of mining, construction, road-building equipment and cranes, has become the latest associate member of the Cement & Concrete Institute (C&CI).

Terex Corporation is the third largest producer of construction and mining equipment in the world. All the products that Terex Africa supplies are manufactured by the Terex Corporation, which is known globally for its wide range of quality and innovative capital equipment.

Terex Africa’s sales territory and service network extends through South Africa, Angola, Botswana, Namibia, Malawi, Mozambique, Tanzania, Zimbabwe, Zambia, Madagascar and the Indian Ocean Islands. Terex Africa’s key customers include companies such as Anglo American, De Beers, Aveng and MCC.

The company is currently building new premises in Pomona in Ekurhuleni and will be moving there in the next few months.

Associate C&CI membership is reserved for companies involved in the manufacture or construction of concrete products or infrastructure, or suppliers of services or goods to the concrete products of concrete construction industry. C&CI now has 11 associate members. The two other membership categories are...
and how successfully things have progressed.

Richard Saxby, CEO Liviero Civils, concurs. ‘This premium on safety demands excellent organisation and logistics. We have worked well as part of a bigger team and from our once-a-week scheduling meeting through to the completion of the finest details on the job, we have managed to work in tandem with one another to the benefit of all concerned,’ concludes Saxby.

Soccer City, South Africa’s premier soccer venue, will hold 95,000 people. First built in 1987, it has played host to some of the most memorable matches in the country’s soccer history. The stadium is home to the South African Football Association (SAFA) and is often used as a venue for matches featuring Bafana Bafana, as well as the massive local rivalry between Kaizer Chiefs and Orlando Pirates.

LIVIERO CIVILS, one of the fastest growing civil engineering contractors in South Africa is developing a reputation not only for its professionalism but also for its versatility, handling a broad spectrum of contracts for a wide range of blue-chip clients.

One of its current high-profile projects is Johannesburg’s Soccer City Stadium where the official opening and the final of the 2010 FIFA World Cup will take place. This contract is as much a story of Liviero’s technical and organisational ability as it is a story about its ability to work as part of what is essentially a large and diverse team led by the main contractor, Grinaker-LTA.

In essence Liviero has been responsible for all the bulk earthworks, excavation of shafts, base excavations and the complete construction of the massive basement parking area.

In addition it was responsible for constructing an access ‘platform’ around the stadium, which required more than 120,000 m$^3$ of fill and 90,000 m$^3$ of cut.

The reuse of much of the material demolished from the old stadium was one of the most innovative aspects of the job. In this regard, Liviero crushed the original concrete and steel to make more than 36,000 m$^3$ of GS material which was used as the top 50 mm layer of the compacted fill of the access ‘platform’.

Liviero’s site agent James Rosslee, whose passion for the contract is immediately apparent, shows off the enormity of the task, how well the various teams have worked together and how successfully things have progressed.
BUENOS AIRES TO STAGE INTERNATIONAL CONCRETE BLOCK PAVING CONFERENCE

SEPT (Small Element Paving Technologists), the international segmental paving association, will be holding its triennial conference and exhibition in Buenos Aires in October next year. This decision was confirmed in March at an executive workshop held in Sydney, Australia.

John Cairns, CMA (Concrete Manufacturers Association) director, who is a member of the SEPT executive committee, says that decisions on the venues for two subsequent SEPT events were also reached in Sydney, these being a workshop in Germany in May 2011 and the 2012 conference which will be held in Shanghai in October of that year. The last conference was held in 2006 in San Francisco.

‘Shanghai was chosen as the venue for 2012 because it will be staging Bauma, the international trade fair for construction machinery, at the same time as SEPT. Germany was earmarked for the 2011 workshop primarily because it is by far the world’s largest user of concrete block paving. These conferences/workshops generate technical information on interlocking concrete pavements, permeable interlocking concrete pavements and paving slabs, and attract worldwide interest,’ says Cairns.

The SEPT committee, comprising 20 CBP (concrete block paving) experts from around the world, meet every 18 months, at the triennial conferences, and once between them, at the planning workshops. Besides having reached decisions on the venues for upcoming conferences, several papers were presented in Sydney, most of them on permeable paving.

Cairns believes permeable paving has a very important role to play in South Africa’s rain water management, but that its widespread deployment is dependent upon government intervention.

‘Despite its obvious benefits, such as controlling stormwater run-off, removing pollutants from rain water and conserving water, permeable paving will only take hold if it is mandated through legislation. In Germany, which is also the world’s largest user of permeable paving, taxes are levied on stormwater run-off. In South Africa, most new property developments must now provide some form of water management system, either through attenuation ponds or permeable paving.’

Cairns says that South Africa will be the world’s second country to acquire formal mechanistic design software for permeable paving, PermPave. Developed in Australia by world-renowned paving expert Professor Brian Shackel and the University of South Australia, PermPave will be launched in South Africa later this year.

In addition to being the world’s most advanced permeable paving software, the South African version will be programmed with relevant information pertaining to local storm water conditions. Local seminars on PermPave will be held by Professor Shackel and Professor Beecham of the University of South Australia in July.

Cairns said that bonded pavements using flagstones was also discussed in Sydney.

‘This type of pavement has open joints which are filled with a mortar. Problems have been encountered all over the world with flagstone paving for vehicular traffic and is generally not recommended for this type of loading.’

PROVIDING SOLUTIONS FOR UNIQUE MINING 3D SURVEY CHALLENGES

GEOSYSTEMS AFRICA, a company providing surveying, measurement and geosolutions, is supplying Leica 1200 Total Station theodolite systems to the South Deep Gold Mine for the GiijimaAST software project initiated by Heinrich Schnetler, Gold Fields Limited group surveyor.

‘Gold Fields grew its unique franchise of owning and operating a few large high-quality long-life assets through the acquisition of South Deep Gold Mine in January 2007,’ says Schnetler. ‘As at June 2007, South Deep has measured and indicated resources of 288,1 million tons containing 66,6 million ounces while the proved and probable reserves are 30,4 million ounces contained in 154,9 million tons.’

The mine, approximately 60 km south-west of Johannesburg, exploits reefs of the Witwatersrand Supergroup, which is the most intensively studied sequence of rocks in southern Africa. A full study to examine the optimisation of the Kloof/South Deep complex is ongoing and the operation is expected to be viable for the next 40 years. The development of South Deep is therefore a major project and is supported by intensive and ongoing investment in new and state-of-the-art technology.

The reef ‘wedge’ currently being exploited attains a thickness of approximately 120 m towards the eastern boundary of the mining authorisation and is mined by a variety of methods ranging from conventional narrow stoping to trackless mining (mechanised drift and fill with benching).

‘Surveying the various excavations presented a range of unique challenges, including the difficulties associated with the relative inaccessibility of the workplaces,’ says Schnetler. ‘Gold Fields Chief Surveyor Zack Letschuti is currently leading a project to ensure that all measurements are captured electronically and in 3D space. To achieve these volumetric measurements, Gold Fields acquired a range of Leica Geosystems equipment from GeoSystems Africa. The main Leica Geosystem products currently being utilised are the motorised Leica 1200 Total Stations, which are being used in conjunction with the GiijimaAST mineMARKUP software. Training and skills transfer in the use of the Leica 1200 Total Stations and the software has already started.’

‘This project is the dawn of a new era for mine surveying in South African gold mines, especially the move from two- to three-dimensional data capture, analysis and presentation. Various benefits are envisaged through the implementation of this strategy: enhancement of the skills level and work satisfaction of staff; all underground excavations will be surveyed and voided to the required level of detail; inaccessible stopes can now be scanned with the motorised Leica TCR1205 Total Station; improved safety as a result of remote access to the massive or inaccessible stopes; improved productivity through enhanced analysis of observations and resultant decision making; integrated data flow resulting in the voids being immediately available to other disciplines (mine planning, geology and evaluation); accurate reconciliation of excavations between the actual measured void and the design or block models; and mine planners can improve stope and development layouts based on higher confidence in the existing voids.’

Schnetler said that it is expected that all survey measurements at South Deep will be done using the volumetric approach within six months. Following this implementation, rollout of volumetric surveying will also be investigated at other Gold Fields mines.
PERMEABLE PAVING TAKES ROOT

PERMEABLE PAVING, a process which manages and harnesses water run-off in an eco-friendly and efficient manner, offers huge advantages to a water-scarce South Africa. In the past eight months seven permeable paving projects have been completed by Concrete Manufacturers Association (CMA) member Concor Technicrete.

These projects involve domestic and light industrial applications and vary in size from 204 m² to 4 240 m². Six of them are attenuation-based and the seventh is an infiltration system. Concor’s concrete pavers, the Aqua Trojan slab measuring 206 mm x 135 mm and its AquaTrojan Square measuring 135 mm x 135 mm, were used on the projects.

Permeable paving functions in one of two ways, either soaking surface storm water back into the groundwater table, or storing and then channeling it into storage sumps or tanks as ‘grey’ water to be used for cleaning purposes, flushing toilets and the hydration of gardens.

Although permeable paving technology has been in play for the past 20 years, its use has been essentially confined to the first world, primarily the EU, UK and USA and, more recently, Australia, where it was introduced some ten years ago. Despite its obvious water management benefits, South Africa has been slow to catch on – mainly because most of our engineers were taught that paving should prevent and not promote water infiltration. However, new local government requirements on the control of stormwater run-off means that many more projects are in the offing.

CMA director John Cairns says the CMA fully endorses permeable paving technology. ‘We hosted a paving seminar last year in which a course on permeable paving was run by one of the world’s leading experts on the technology, Australia’s Professor Brian Shackel. He also participated in this year’s ICCX conference at Sun City where he delivered a paper on “The design and application of interlocking paving”.

‘He returns to South Africa in July with Professor Simon Beecham of the University of South Australia to run a series of seminars on PermPave, a permeable paving design software system developed by the two professors and other members of the University of South Australia. Professor Beecham wrote the hydraulic section of the programme, which in the South African version incorporates local stormwater information,’ says Cairns.

Interviewed after ICCX, Professor Shackel observed that although permeable paving...
technology was introduced into Australia in the early 1990s, it is still in its infancy in that country. He says the main reason for this, as in the case in South Africa, is resistance from engineers.

‘We have found landscape architects far more willing to promote the system. Both countries are water scarce and in Australia new housing plans are only approved if they can show a 40 % reduction in water usage.

‘Permeable paving, which can channel water into storage tanks or the underground water table, can certainly help alleviate water shortages and, at the same time, remove most pollutants from the water that enters the pavements. However, a more pressing role for permeable paving is to assist government’s urban consolidation policies in reducing the loads that would otherwise be placed on urban stormwater systems,’ says Shackel.

‘Permeable paving is better established in Europe, especially in Germany and Austria where it has been used for the past 20 years at least. Shackel says the essential motivator for its use in Europe are the taxes levied on water run-off into stormwater drainage systems.

‘The recent flooding of major rivers such as the Rhine, Danube and Elbe has more to do with the extensive paving of urbanised areas than it has with excessive rainfall. Germany and other European countries levy a tax on estimated water run-off, which is why permeable paving is finding increasing favour with the Europeans,’ says Shackel.

Both motivators for the deployment of permeable paving apply in the case of South Africa where water is in short supply and where some stormwater drainage systems were designed for lower than existing and projected urban densities.

LIGHTWEIGHT BUILDING BLOCK LAUNCHED

AUTOMA BUILDING PRODUCTS, specialists in the design and manufacture of expanded polystyrene systems (EPS), has launched an environmentally friendly alternative walling system that replaces conventional bricks and mortar.

‘This lightweight Polyblock system, which is a hollow EPS building block that acts as a permanent formwork for a reinforced concrete infill, is used for building houses, high-rise buildings, perimeter and retaining walls, as well as infill panels for steel construction,’ says Craig Paton-Ash, director of Automa Building Products. ‘EPS is gaining popularity in the building sector globally because of its substantial savings in the energy costs involved in heating and cooling.

Polyblocks have a wall thickness of 30 mm and stay in place acting as a thermal insulator for the building, keeping the structure warm in winter and cool in summer. This ensures substantial savings in the energy costs involved in heating and cooling.

Automa Building Products has extended this hollow building block wall system to include a new metal hopper that ensures clean and easy concrete filling. The metal hopper is made of 1.6 mm thick sheet metal and is the length of the 1 200 mm Polyblock. The newly designed hopper is tapered to give a top opening of 240 mm to fit into the hollow core of the block, which is 120 mm wide.

The purpose of the hopper is to provide a larger opening to efficiently funnel the concrete into each block and also to keep the top of the block free of concrete so the next layer of Polyblocks locates easily, without the need for cleaning and this speeds up the block filling operation. Each hopper is supplied with a red oxide primer as protection against corrosion.

To complete the Polyblock system, a special EPS plaster, Polyplast, is recommended. Automa Building Products has recently opened a training facility and permanent product showroom at the company’s Isando premises. This facility offers the training of builders in the use of different expanded polystyrene systems and shows specifiers how these innovative products can be efficiently utilised.

MAPEI LAUNCHES SADC INITIATIVE AT ICCX CONFERENCE

FOLLOWING AN ANNOUNCEMENT last year that it would be servicing the Southern African Development Community (SADC) region, multinational construction chemicals group Mapei held its official launch during ICCX (International Concrete Conference and Exhibition) at Sun City in February.

With annual global revenues in excess of R16 billion, Mapei highlighted its intention of becoming a major player in the region when eight senior executives came to South Africa to participate in the launch. Meeting and networking with construction professionals at the ICCX, the high-powered delegation included Mapei’s CEO, Dr Giorgio Squinzi, operational marketing and communication director Dr Adriana Spazzoli, strategic planning director Craig Paton-Ash

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South African in South Africa, as we are Italian management system and therefore we are Systems (ECS).

"It’s very easy to mix and apply and comes with higher liquid content than Mapelastic Mapelastic Smart is shortly before applying. Having a higher liquid and liquid packs which are mixed together in two versions, Mapelastic and Mapelastic in two versions, Mapelastic and Mapelastic Smart. Both are supplied in separate powder and extendibility means that structures which develop cracks as wide as 1 mm wide will be protected,’ says Aucamp.

‘It has excellent adhesion and elasticity properties which ensure long-term stability and besides waterproofing, it shields concrete structures from the aggressive action of carbon dioxide as well as protecting steel reinforcing in concrete from the salt in sea water. Moreover, Mapelastic’s high elasticity and extendibility means that structures which develop cracks as wide as 1 mm wide will be protected,’ says Aucamp.

Owing to rheological properties which give Mapelastic its plastic consistency, it can be applied either by trowel or by spraying.

‘It’s very easy to mix and apply and comes in two versions, Mapelastic and Mapelastic Smart. Both are supplied in separate powder and liquid packs which are mixed together shortly before applying. Having a higher liquid content than Mapelastic Mapelastic Smart is a more flexible material and is well suited to South Africa’s sunny weather conditions.

A WORLD-LEADING waterproofing and protection agent for concrete surfaces, Mapelastic, a product manufactured by the multinational construction chemicals group Mapei, is now available throughout southern Africa from Engineered Concrete Systems (ECS).

Mapelastic is a versatile and waterproofing material which is suitable for a wide range of applications from waterproofing large infrastructural projects such as concrete dams, canals, reservoirs, piers, bridges and water towers, to the protection of domestic installations such as swimming pools, baths and showers. Proven for over 15 years in waterproofing and protecting more than 60 million square metres of concrete surfacing, it is specified by professionals all over the world.

ECS product manager Pieter Aucamp says that Mapelastic is a cementitious membrane which, thanks to a high synthetic resin content, retains flexibility and water resistance up to pressures of 3 atm.

‘We believe in situating our factories close to our customers so that they can be provided with the lowest possible costs and the quickest possible delivery times.’

Mapei has grown from a small family-run business founded in 1937 by Dr Squinzi’s father into a major multinational concern. Despite its size, it is still controlled by the Squinzi family.

Dr Squinzi observed that the success of the group has been founded on three pillars, namely specialisation, a strong international presence, and research and development.

‘Five per cent of the group’s turnover is spent on research and development in cooperation with many of the world’s major universities and we were the first to introduce PCE admixtures to the global market. We have also introduced new products to many other countries, and our Norwegian operation was the first to introduce several new products in that part of Scandinavia,’ said Dr Squinzi.

Seven Mapei R&D laboratories are operated worldwide, two in Italy, and one each in France, Germany, Norway, Canada and the other countries. ECS is staffed by local people well versed in the requirements and idiosyncrasies of the local construction industry. Products currently being supplied locally include admixtures for concrete, products for construction, and cementitious and resin floor coatings.

‘Our entry into the southern African market means that we have extended our global reach. Worldwide we deliver 16 000 tons of product to 40 000 customers daily,’ Dr Squinzi observed.

During his address Dr Squinzi announced that Mapei would be building a local manufacturing facility in line with Mapei’s policy of manufacturing in the countries it serves. The local plant will be Mapei’s 47th, and like all its other factories, it will comply with ISO 9001 standards.

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VERONICA SQUINZI, strategic marketing director Walter Nussbaumer, and export area manager Derk Borneman.

Mapei’s innovative and comprehensive range of auxiliary and enhancement materials for the construction industry attracted wide interest from conference delegates and visitors.

In an address to conference delegates, Dr Squinzi noted that Mapei was involved in the huge wave of construction growth currently under way in countries in the eastern part of Europe such as Poland, Hungary, Rumania, and more especially Russia, where the growth in demand for Mapei’s substantial product range is the world’s highest. The group currently operates through 50 associate companies with 47 production facilities across 33 countries worldwide.

Dr Squinzi was introduced to a large gathering of conference delegates by Aveng Group CEO Carl Grim, who spoke briefly about Mapei’sering of conference delegates by Aveng Group CEO Carl Grim, who spoke briefly about Mapei’s willing venture with Aveng. Dr Squinzi noted that there is huge growth potential in the local construction industry and that he wanted Mapei to participate in and contribute to it.

‘We have signed a local distribution agreement with the Aveng Group and a comprehensive range of enhancement products for the construction industry is already being distributed by its subsidiary, Engineered Concrete Systems (ECS).

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INFO

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If surfaces are badly stressed or cracked, fibre mesh can be inserted into the Mapelastic shortly after application. A second coat can then be applied to cover the mesh. Alternatively, Mapelastic can be strengthened using Mapetex Sel, a non-woven, pre-holed polypropylene fabric, advises Aucamp.

PIONEERING PERMEABLE PAVING IN A RELUCTANT MARKET

ONE OF THE fastest growing approaches to green site development in the last year or two is permeable paving. Yet, contrary to popular belief, it seems the approach has been around for years, with the local market reluctant to recognise the obvious potential.

Back in 1994 Terraforce, local and international licensor of interlocking, hollow core concrete products, obtained the rights to the German Exec concrete paving system, which can be installed in a number of attractive patterns as well as in various permeable patterns. Exec Eco-powering was tested by the Institute of Hydraulic Engineering at Karlsruhe University, and in the same year the system was launched by Dave King of Inca Cape.

Holger Rust, owner of Terraforce for the past 28 years, was hopeful that this new approach would excite the market with its water-wise features, but 13 years ago, awareness of the benefits and advantages of permeable paving was virtually non-existent.

‘Exec remained a small player, available from Deranco blocks in Port Elizabeth. Meanwhile we developed Terracrete hardlawn, a larger version of Exec with internal openings, suitable for installing hard-wearing, permeable eco-surfaces on roadways, parking areas or for mixed use installations such as stormwater.
2008 SAICE PHOTO COMPETITION

COMPETITION RULES:

1. The competition is open to the general public to submit photographs.
2. It is essential that entries portray people and/or projects in civil engineering.
3. Photographs will be judged in ONE general category only.
4. Entries must be colour prints and in A4 size. Only quality prints will be accepted. Please supply electronic copies of the print/s in jpeg format, 300dpi.
5. Please complete an entry form for each entry and supply an appropriate title & short description of each project. It is essential that the photographer’s name is included.
6. Please supply details of the client, consultant and contractor involved in the project.
7. The entrant is responsible for obtaining permission for the use of the photographic material as well as subject material from the authority or project manager concerned.
8. Entries submitted by organisations must be accompanied by written consent of the photographer.
9. Permission for the reproduction of the photographs for any exhibition or publicity is assumed unless the entrant specifies otherwise. Due recognition will be given to the photographer.
10. No responsibility will be accepted for any loss or damage to entries.
11. Closing date: 25 July 2008

This section must be completed by the person submitting the photo/s

NAME__________________________________________
ADDRESS__________________________________________
TEL____________________FAX____________________
E-MAIL__________________________________________
PHOTO TITLE ____________________________________
DESCRIPTION___________________________________
________________________________________________
PROJECT INFO _________________________________
_______________________________________________

PHOTOGRAPHER____________________________ Name and surname of the photographer

If you are not the photographer or if you are submitting the photograph on behalf of a company owning the photograph, please sign on behalf of.

I hereby grant permission for reproduction and agree to abide by the rules of the competition.

Signature:__________________________________

This section must be completed by the photographer or the company that owns the photo.

If you are not the photographer or if you are submitting the photograph on behalf of a company owning the photograph, please sign on behalf of.

I hereby grant permission for reproduction and agree to abide by the rules of the competition.

Signature:__________________________________

NB: The entrant’s name, address and title (all of which must correspond with details on the entry form) must appear on the back of the print.

2007 winner: Drilling holes, taken by Kevin Wright

1st runner-up: ‘Construction Reflection’ entered by Johan Gilbreer. Photograph taken by Eduard de Wet

2nd runner-up: ‘Klein Karoo Opera House’ submitted and photographed by Jasper van Breda

2008 SMART aWARDS

Prizes sponsored by Sanlam COBALT

South Africa's SMART legacy - cat's eyes, the dolos, the impact roller, the CAT Scan, the Kreepy Krauly … Are YOU as SMART or SMARTer than this?

Do YOU have innovative ideas/projects/equipment to resolve, for instance,

- traffic congestion
- water conservation/recycling issues
- sustainable housing for healthy communities
- South Africa's sanitation backlog
- ergonomic challenges for women in construction, e.g. lightweight tools

OR

- have YOU designed a small section of a BIG project that provides a solution, as for ALL the above, that is

- sustainable
- magnificent thinking/innovation
- amazing solution
- right for the time and place
- truly and proudly Civils South Africa

If YOU answered YES to even some of the above, SAICE needs YOUR submission!
The SMART Awards are awarded to individuals and not to projects.

ENTRY FORM: Please contact Zina Girald on e-mail: zgirald@saice.org.za

This form is available on the SAICE website: http://www.civils.org.za/EventsAwards/PhotoCompetition/tabid/115/Default.aspx
detention ponds as well as for general erosion control measures.’

Terracrete was launched in 1999 and received a cool reception in the market. Says Rust: ‘Even the development of plastic moulds that allowed for production on a small scale with minimal capital outlay did not help much. Finally, during the years 2002 to 2004 specifiers started to accept the concept and sales started to pick up.’ Today Terracrete is available locally in the Western, Eastern and Northern Cape, KwaZulu-Natal and Gauteng and internationally in Swaziland, Namibia, the United Arab Emirates, India, Australia and Turkey.

Permeable paving or eco-surfaces are now the latest trend; a little belated, but at last the market is now willing to look at a new directions and ideas in paving practice. Rust himself describes a new method of creating permeable and efficient drainage/infiltration in existing paved areas or in new areas that are to be paved with asphalt or interlocking clay/concrete pavers. ‘The incorporation of drainage lines along edges, around perimeters and at predetermined centres across parking/storage areas or roadways makes it possible to upgrade existing ones or enhances drainage/infiltration of new installations. This method can also be applied when new service or irrigation lines have to cut across existing parking areas while trees are established at the same time.’

Rust says Terracrete is ideally suited to this purpose as it is a paving block with openings (40% open) compared to paving blocks with widened joints (15% open). The bigger openings allow for coarse infill to be used, which means better infiltration and easier maintenance.

CHRYSO ADMIXTURE FOR SOCCER CITY COLUMNS

AN ADMIXTURE FROM Chryso SA forms an important part of the self-compacting concrete mix being used for the construction of the columns at Johannesburg’s 2010 soccer stadium, the FNB Stadium, more popularly known as Soccer City.

The concrete mix for the columns was designed by George Evans, concrete services manager of Grinaker-LTA; and Darren Jacobs, of W G Weane Readymix. Grinaker-LTA is the main contractor for the stadium project, and W G Weane is supplying the concrete from its on-site dry batch plant.

The Chryso admixture selected for the column construction is the company’s ‘super-plasticiser’, Chrysofluid Optima 100.

Eddie Correia, Chryso SA GM technical services, says an unusual aspect of the concrete mix for the columns is that the concrete was optimised with a fine lime stone filler. ‘We believe this is the first time this has been done in South Africa,’ he stated.

The site agent for Soccer City is Ken Marsden, and the site foreman is Achmat Tahap.

Soccer City – where the opening and final fixtures for the Soccer World Cup will be played in two years’ time – is only one of several 2010 soccer stadiums for which Chryso SA is supplying admixtures for the concrete mix.

The company’s admixtures are being supplied to Lafarge Concrete for the Mbombela Stadium in Nelspruit, the Nelson Mandela Stadium in Port Elizabeth, the Moses Mabhida Stadium in Durban, the Green Point Stadium in Cape Town, and Soccer City in Johannesburg.

In addition, Chryso admixtures are also being used by Meyker Construction, the precast contractors for Vodacom Park, Bloemfontein; and will be used by Blitz Concrete for the precast elements of the Mbombela Stadium in Nelspruit.
ENGINEERING COMPANY ENCOURAGES LEARNERS

‘ENGINEERING FIRMS have a responsibility to encourage learners to consider entering the field of engineering when they finish school. However, one also has to promote at secondary level an interest in the subjects that will enable them to enter the engineering profession,’ says Heather Kinghorn, of WSP Group Africa.

One of the contributing factors to the skills crisis in the engineering industry is the low number of mathematics and science learners at secondary level. Research conducted two years ago showed that less than 10 % of Grade 12 learners did higher grade mathematics and science. This number has since declined, with a very small percentage of Grade 12s annually graduating with higher grade mathematics and science. These learners then further disperse themselves between the commerce, medical and sciences faculties at tertiary level.

The engineering industry has historically been actively involved in bursary schemes. This hasn’t changed as the construction education and training sector authority, CETA, is focused more on artisan qualifications than tertiary qualifications. WSP Group Africa has some 35 employees on bursaries worth nearly R700 000 across all of the engineering disciplines. Kinghorn explains: ‘We traditionally sponsor students from their 2nd year because the fallout rate is so high amongst first-year engineering students – nearly 70 % of first-year student don’t progress to their second year!’

Realising that learners need to be recruited at secondary level, WSP has also become involved with SAILI, a science and industrial leadership programme based in Cape Town. The NGO’s role is to promote improvement in mathematics and science education for disadvantaged learners at a secondary level to assist them in gaining access to tertiary qualifications. WSP will recruit a student who has come through the SAILI programme and give him or her a bursary to study engineering. WSP also provides some of SAILI’s Grade 11 and 12 learners with practical work experience, and includes some of the learners in the Bring a Girl Child to Work initiative. Two of SAILI’s university students spend their vacations working at WSP’s offices. WSP also sponsors prizes at the NGO’s annual prizegiving ceremony.

To recruit students at tertiary level, WSP has a graduate induction programme at universities and technikons countrywide where students can attend presentations given by young WSP engineers on what it is like to work in an engineering environment.

Kinghorn concludes: ‘We are doing what we can to encourage learners to enter the engineering profession, but the candidate pool is so small and with projects such as the Gautrain and the 2010 FIFA World Cup looming, we are realising just how great our need is for experienced engineers and infrastructure spend over the next seven years.’

SIKA CONVERTS TO SUSTAINABLE FLOORING PRODUCTS

SIKA SA HAS taken several steps towards endorsing environmental safety and protection, with a view to providing more ecologically sound, sustainable floor coverings to the industry.

As a manufacturer, Sika SA is in the process of moving away from the production of solvent-based materials as these are more harmful to the environment. Instead it has found other alternative ingredients that are more ecologically sound, or water based, to replace the solvents that are predominantly used in construction.

SikaFloor-2530 W will replace SikaFloor-65ZA from early 2008 as it is in the process of changing from a solvent-based system to a water-based system. SikaFloor-2530 W is a two-part, water dispersed, solvent free, coloured, epoxy resin based coating, which is used for concrete, cement screeds, broadcast systems and epoxy mortars. It can be subjected to sound, or water based, to replace the solvents of moving away from the production of solvent-based products.

SikaFloor-2530 W is available in a variety of colours, is water vapour permeable, water dilutable, odourless and it offers good chemical and mechanical resistance.

WSA COMPLIANCE FOR THE CITY OF UMHLATHUZE

uMhlathuze Municipality supplies water and sanitation services to the towns of Empangeni, Richards Bay, eSikhakheni, Ngwelezane, eNseleni, Vulindela and Felixton, as well as the rural areas of Dube, Mkhwanazi, Khoza and Madlebe.

Systems Integrator SSE KwaZulu-Natal (KZN) installed one of South Africa’s most advanced telemetry solutions and an Adroit Supervisory Control and Data Acquisition (SCADA) system to enable the uMhlathuze Council to profile the quality of all water resources.

The project was started in January 2007 and will continue until 2011 through a service level agreement (SLA) that entitles the client to repay, risk free, all capital layout expenses for approximately 135 sites over this period while the system is ensured and maintained by SSE KZN.

Utilisation of the Adroit SCADA trend analysis will enable the council to predict future changes in the quality of the water resources. Trending is performed for levels, pH, flows, pressures and pump starts with all data being logged for 6- to 12-month periods.

The City of uMhlathuze, situated on the north-east coast of KwaZulu-Natal, South

www.sika.co.za

Screen grab of the uMhlathuze Municipality system from the Adroit SCADA
Africa, is a progressive municipality dedicated to achieving a successful balance and synergy between industry, its rich environmental assets and the community. Richards Bay is considered to be the industrial and tourism hub, Empangeni the commercial hub and eSikheleni the largest suburb.

Effective management of services and resources and the provision of services to all residents of the city, which is 796 km² in extent, are challenges that the municipality has tackled enthusiastically. The municipality’s developments in this regard are on track and, in many instances, ahead of national government’s targets. The municipal area has a water pipe infrastructure of 1 696 km, reservoir capacities of 240 Mℓ, a total of 614 km of sewer pipes and four treatment works which process approximately 100 Mℓ per day.

TECHNOLOGICALLY INNOVATIVE MILESTONE FOR THE NWU

NoRTH-WEST UNIVERSITY (NWU) and the Pebble Bed Modular Reactor Pty (Ltd) of South Africa (PBMR) signed a cooperation agreement on 26 February 2008, according to which PBMR will sponsor research work conducted by the NWU in the field of nuclear engineering.

Dr Theuns Eloff, Vice-Chancellor of the NWU, emphasised that the NWU strives to demonstrate its innovative spirit in all its endeavours, adding that the NWU is a new-generation university whose mission is to become an effective and transformed balanced tuition and research university.

‘The signing of the contract with PBMR is a perfect example of how relevant research excellence, technology transfer and partnerships with industry are coming together,’ says Dr Eloff. ‘Together with PBMR the NWU has through research excellence put technology into practice to ensure that we have practical solutions for the energy crisis that is facing South Africa at present. The NWU is indeed locally engaged, nationally relevant and internationally recognised.’

One of the projects arising from the agreement between the NWU and PMBR involves research in the field of femtochemistry and laser spectroscopy.

This project entails new methods using lasers to prepare existing or new compounds with greater selectivity. Using this new technology will result in far lesser amounts of waste or by-products and will subsequently be more environmentally friendly.

Areas such as pharmacology (drugs), agriculture, nutritional supplements, energy, fuel and others will benefit from this relatively new technology.

Another NWU faculty that is working closely with PBMR through this joint venture is the Faculty of Engineering on the Potchefstroom campus.

This faculty has been involved with the PBMR project since 1997. Faculty personnel were tasked to develop a thermal hydraulic design code for the PBMR. This code, Flownex, is being used by PBMR since 2000 to perform various design functions. The extension and further refinement of the code is a continuous task that is still being performed.

In 2006 two important testing facilities, the so-called heat transfer test facility (HTTF), comprising the high pressure test unit (HPTU) and the high temperature test unit, were established at the NWU. Research carried out for PBMR at these facilities is of national importance in the quest for sustainable energy sources.

The forthcoming agreement between PBMR and the NWU makes provision for the extension of existing projects and the development of new ones. These projects include the development of processes that are linked to PBMR technology, such as the use of nuclear power to desalt sea water and the testing of plant components of the PBMR, such as heat exchangers, valves and materials.

This technologically innovative milestone follows barely two years after the NWU received a prestigious accolade as the most progressive, technologically innovative university in South Africa in the National Innovation Competition hosted by the Department of Science and Technology.

NUCLEAR POWER ‘BEST ENERGY SOURCE’

NUCLEAR POWER is the only non-greenhouse gas emitting energy source that can effectively replace fossil fuels and satisfy global demand.

This is the opinion of Dr Patrick Moore, internationally renowned environmentalist and chairperson of Greenspirit Strategies, who visited North-West University (NWU) on 4 March 2008 to share his perspectives on alternative energy sources and the implications of nuclear power for South Africa and the world.

Dr Moore believes that nuclear energy is not only cleaner than energy from fossil fuels, but also more sustainable than other energy sources such as fossil fuel, wind, and the sun.

In his opinion, hydroelectric plants and nuclear plants are the best options for base load to sustain a country’s economy. He is also positive about wood and geo-thermal sources as renewable energy sources. He points out that wood captures carbon and, when replaced with new trees upon felling, wood recycles the carbon contained in it. When put to good use, wood, containing approximately 50 % carbon, can be viewed as sequestering carbon.

‘If we have to weigh the consequences of introducing nuclear energy or not, taking into account the carbon dioxide emissions and the future depletion of fossil fuel, it is clear that the pros are more than the cons,’ Dr Moore said.

After a visit to North-West University’s Pebble Bed Micro Module test facility (PBMM) and the Heat Transfer Test Facility at the Faculty of Engineering, Dr Moore said that nuclear energy produced by a high-temperature gas cooled nuclear such as the Pebble Bed Modular Reactor (PBMR), is superior to conventional nuclear power plants since the heat from the PBMR can be used in thermo-chemical water splitting (producing hydrogen for industrial use), as process heat (for example in the petrochemical industry) and for desalination or water purification.

Even with nuclear power cycles, the amount of carbon dioxide produced in the full lifecycle of nuclear energy production represents only 2 % of the total amount produced by fossil fuel power plants as a result of the manufacturing and transportation (that is, if carbon-based energy is used) involved in erecting the plant.

By burning coal at the current rate, we are consuming 300 million years of fossil fuel in a period of three centuries. Countries like China use huge amounts of coal. It is estimated that China’s coal consumption may, by 2030, equal the current coal consumption of the rest of the world. Burning coal at this rate is not sustainable in the long run.

Energy sources such as wind and solar energy are inherently intermittent, and the energy produced on sunny or windy days currently cannot be stored cost-effectively to use when there is no wind or sun.

One nuclear power plant produces as much energy as between 500 and 1 000 wind turbines. Wind turbines contain much more materials per unit electricity produced than other plants; this increases the so-called carbon footprint of wind energy significantly.

Although the initial capital investment for
nuclear power is high, the costs of nuclear plants compare well with coal power plants and are definitely more cost-effective than wind or solar energy systems.

Solar systems are also very expensive and will only be cost-effective when they cost 10% of what they cost currently. Dr Moore points out that it will take a solar system about seven to nine years to produce the amount of energy it takes to manufacture the system initially.

GOVERNMENTAL COMMITMENTS COMPOUND ELECTRICITY CRISIS

SOUTH AFRICA’S CURRENT power shortage dilemma is compounded by the fact that the government is committed to provide 2 000 MW of electricity to millions of houses, as well as schools and clinics, by the year 2012.

Addressing the annual general meeting of the Gauteng Master Builders Association (GMBA) in Midrand recently, Hans Schefferlie, executive director of the AAAMSA Group, said 3.6 million residences, 5 131 schools and 184 clinics were at present still without any electricity. The government has given a commitment to provide electricity connections to these operations by 2012,’ he stated.

Schefferlie said there were, for example, nearly 800 000 un-electrified households in KwaZulu-Natal, 700 000 in the Eastern–Cape, and over 600 000 in Gauteng. A total of 2 230 schools in KZN and 1 924 in the Eastern Cape still had no electricity, with 150 clinics in the Eastern Cape also not connected to the national power grid.

In addition to this commitment, the government had also undertaken to provide 3 360 MW to various industries such as the new Alcan smelter planned for Coega (2 250 MW) and the steel, paper and pulp industries, primarily at Richards Bay.

‘South Africa, in total, has to install generating capacity of 60 000 MW between now and 2025. This would require 30 Koeberg-type of power stations with minimal carbon dioxide emissions, or 17 conventional coal power stations, putting around 500 million tons of carbon dioxide into the atmosphere. Such pollution would represent a serious transgression of the Kyoto Protocol with subsequent penalising international duties applied to South Africa,’ he warned.

Schefferlie said pebble bed modular reactors, or wind turbine farms, would not provide meaningful solutions to South Africa’s electricity shortage. ‘Such power generation concepts would basically only benefit rural areas,’ he added.

Reacting to Schefferlie’s address, Naudé Klopper, a former president of the GMBA, said the solution to the power crisis would need ‘cool heads’ and joint discussions – without political agendas – by government and the business sector.

LAMP LIT BY GRAVITY WINS GREENER GADGET AWARD

A VIRGINIA TECH student has created a floor lamp powered by gravity. Clay Moulton of Springfield, Virginia, created the lamp as a part of this master’s thesis. The LED lamp, named Gravia, recently won second place in the Greener Gadgets Design Competition as part of the Greener Gadgets The Gravia LED lamp will be powered by gravity. The entire column will glow

The Gravia LED lamp will be powered by gravity. The entire column will glow
Gravia deploys an acrylic column a little over four feet high. The entire column glows when activated. The electricity is generated by the slow fall of a mass that spins a rotor. The operation is silent and the housing is elegant and cord free – completely independent of electrical infrastructure.

The light output will be 600–800 lumens – roughly equal to a 40 watt incandescent bulb over a period of four hours.

Moulton estimates that Gravia’s mechanisms will last more than 200 years, if used eight hours a day, 365 days a year. ‘The LEDs, which are generally considered long-life devices, become short-life components in comparison to the drive mechanisms,’ he said.

‘The acrylic lens will be altered by time in an attractive fashion. The LEDs produce a slightly unnatural blue-ish light. As the acrylic ages, it becomes slightly yellowed and crazed through exposure to ultraviolet light. The yellowing and crazing will tend to mitigate the unnatural blue hue of the LED light. Thus, Gravia will produce a more natural color of light with age,’ he explained.

**BOHLWEKI ENVIRONMENTAL CONDUCTS EIAS FOR TWO NEW FUEL PIPELINES**

BOHLWEKI SSI ENVIRONMENTAL, the environmental arm of consulting engineering and project management group SSI – a DHV company, in Joint Venture (JV) with SiWest, has been awarded a project worth in the region of R3,5 million to conduct environmental impact assessments (EIAs) for two proposed high pressure fuel pipelines by Transnet Pipelines, part of Transnet Limited.

These pipelines are part of the greater multi-billion rand New Multi-Products Pipeline project (NMPP) – the largest undertaking of its kind to date in South Africa – which is intended to help alleviate capacity constraints in the petroleum supply chain by transporting product from the coastal terminal to the inland network.

Bohlweki has been tasked with conducting EIAs in the areas around the proposed pipelines that will transport fuel from Jameson Park to Langlaagte, via Alrode, in Gauteng – a distance of about 78 km – and an approximate stretch of 84 km from Kendal to Waltloo.

‘Each EIA comprises a number of specialist studies, such as noise, visual, flora/fauna, dolomite, wetlands, social, geohydrology and seismic,’ says Bohlweki sector group manager Jannette Horn. ‘These studies have now been completed and the draft environmental impact reports (EIRs) are in the public domain (39 different locations along the proposed route) for review until 9 February 2008. In addition, we’ve arranged several open days at various locations in the affected areas where interested and affected parties could view these documents and put their questions and concerns directly to key members of the environmental team (Bohlweki), Transnet and the contracting engineers.

‘These pipelines cover extensive distances and will therefore affect many different groups of people. As a result of our comprehensive public participation process, numerous comments were received and incorporated into our draft EIRs. A lot of these suggestions from interested and affected parties lead to alternative route alignments considered as part of the EIA process.

‘After the public review period has closed, we will incorporate the public’s comments into our findings and submit this together with our environmental management report to the relevant authorities for issuing of an environmental authorisation.’

A document issued by the Department of Public Enterprises (DPE) says the strategically important NMPP project proposes to construct a trunkline and interrelated pipelines totalling approximately 700 km in length, new pump stations, and delivery depots throughout the KwaZulu-Natal, Free State, Gauteng and Mpumalanga provinces. The new pipelines will be engineered and installed in accordance with internationally accepted standards and procedures and will be cognisant of South African regulations.

The DPE says economic growth in South Africa has created an increased demand for petroleum products, particularly in Gauteng. The current Durban–Johannesburg pipeline will become capacity constrained over the next few years as a result of the increase in product demand and will eventually be incapable of supplying the needs of fuel to customers. It is envisaged that the new pipelines and associated facilities will increase the capacity and flexibility of the existing pipeline network.
President for 2008 inaugurated

The Members’ Function 2008 was held on 21 February in Midrand. On this occasion, Johan de Koker was inaugurated as the SAICE president for 2008.

SAICE’s president for 2008, Johan de Koker
Zina Girald, SAICE communications officer, unchaining Neil Macleod, president for 2007
Putting Johan in chains
Alec Hay, president in 1996
Bob Pullen, president in 1989
Presidents sharing a toast – Moses Maliba, president of IMESA, and Johan de Koker
Johan handing Neil a certificate of thanks for his valued contribution to SAICE during his term of office in 2007
(photographs: Tony Stone)
THE REVISED STANDARD on the basis for structural design and actions on buildings and similar industrial structures SANS 10160 (Draft) is in its final stages of preparation.

This follows a long period of revision and development of the present South African Loading Code SABS 0160-1989, which was initiated after the SA National Conference on Loading of 1998. The objective of this article is to report on the progress made with the revision process and to provide some background to its development.

The central role played by Eurocode in the formulation of SANS 10160 is also outlined. Developments in Eurocode during the conversion from the pre-standard ENV Eurocode to the normative EN Eurocode, which started in 1998, in turn, played a key role in the decision to reference SANS 10160 to appropriate parts of Eurocode.

HISTORICAL DEVELOPMENT OF REVISION

The first step concerning the revision of SABS 0160-1989 was taken at the South African National Conference on Loading held in 1998. Towards the development of a unified approach to design loading on buildings and industrial structures for South Africa. Guidelines formulated at the Loading Conference for the revision of SABS 0160-1989 included reference to ISO standards, with specific reference to ISO 2394 General principles on reliability for structures; that the revised code should be comparable to international loading codes and similarly compatible with future South African material codes based on international design codes. Incompatibility between SABS 0160-1989 and ENV 1997 Geotechnical design was an important motivation for the Loading Conference. Provision for geotechnical loading was consequently envisaged as an important requirement for the revised SA Loading Code.

The SAICE Working Group on SA Loading Code representing STANSA SC5120.61M Basis of Structures Design and Actions was reconstituted in 1999. Slow progress was made during the period up to 2003 with the development of revised load stipulations and models.

Participation in meetings of CEN TC250 SC1 Actions on structures as observers revealed important changes resulting from the conversion of Eurocode from the pre-norm ENV (Voluntary) to EN (Normative Standards) version. Options in EN 1990 Basis of structural design are allowed which removed the main inconsistency between SABS 0160-1989 and Eurocode on the treatment of combinations of actions. This development allowed access to the full scope of Eurocode standards and its parts. Furthermore, it became clear that EN 1990 converted the principles of ISO 2394 into operational limit states design procedures. Another attractive feature of the Eurocode set of standards was the consistent provision for all material standards, specifically geotechnical design.

During 2004 the application of Eurocode models as reference was evaluated for self-weight and imposed loads, wind actions and crane induced loads on a trial basis. This exercise was sufficiently positive to proceed fully from 2005 with the development of SANS 10160 (Draft) using the appropriate Eurocode parts as reference. In 2006 work on the formulation of the basis for geotechnical design and actions was initiated.

The various SANS 10160 parts are presently in an advanced stage of being prepared for final technical approval by the SAICE Working Group. In a parallel process the parts are being edited into a single standard in accordance with the SABS format, for approval as a Committee Draft (CD) by STANSA SC5120.61M. When this process is completed, it will be published as a Draft South African Standard (DSS) for public comment. Extensive background information is being prepared for this purpose, and the essential features will be presented in the form of seminars.

BASIS FOR THE REVISION OF SANS 0160-1989

The scope of structures provided for in SABS 0160-1989, the associated levels of reliability, actions to be considered and relations with materials-based design standards, have been maintained in SANS 10160. Deviations in scope and contents of SANS 10160, as compared to SABS 0160, derive mainly from the incorporation of improved models and procedures that are, in the main, implemented internationally.

The reliability levels used in SABS 0160-1989 are left unchanged in SANS 10160. This is justified on the basis of acceptable performance of existing structures. The continued use of existing materials-based design standards together with SANS 10160 is based on maintaining existing reliability levels. An extended reliability framework introduced in SANS 10160 however is expected to result in more efficient structures with improved consistency of reliability. These advantages will be realised particularly when the material-based design standards are also revised accordingly.

In addition to SABS 0160-1989, ISO standards, in particular ISO 2394:1998 General principles on reliability for structures (SANS 2394:2004), serve as basic reference for the drafting of SANS 10160. However, SANS 10160 is primarily based on appropriate parts of the Eurocodes as reference. The development of Eurocode into design standards, which are being implemented by Eurocode member states, has played an important role in selecting it as reference to SANS 10160. Both the advances in structural design practice incorporated in Eurocode and the consequent
increase in complexity needed to be considered carefully in the referencing process.

**EUROCODE ADVANCES AND IMPLEMENTATION**

The development of Eurocode went through a number of distinct stages from inception in 1975 to implementation. The first version of Eurocode which became available in the 1980s was converted into the European pre-standards ENV 1991 to ENV 1999 in the 1990s. Further conversion into normative European standards EN 1990 to EN 1999 started in 1998, and is now virtually completed. Table 1 below provides a summary of the 58 Eurocode parts in terms of their main fields of application.

The last phase of implementation is the publication of national Eurocode standards together with their respective national annexes, which is at present in progress. The situation in the UK is indicative of the status of national implementation, where fifteen BS EN parts plus national annexes provide operational national standards. After a maximum period of five years of coexistence, conflicting national standards have to be withdrawn.

The claim that Eurocode represents the most advanced set of structural design standards logically follows from the concerted effort that was spent on their development and refinement over a considerable time, with strong political support and the allocation of resources. The most advanced design procedures, actions, structural behaviour and resistance were selected from the practices of member states. In this manner the degree of harmonisation in structural design practice across Europe was substantially improved.

The advances made in Eurocode derive from its comprehensive scope, advanced procedures and models, rational provisions for reliability with unified application across its scope. Comprehensive provision is made for buildings and civil engineering works. All conventional structural materials are covered. An extensive range of actions is stipulated. Whilst the diverse structural design practices across the Eurocode member states are harmonised, provision is made for the member states to retain responsibility for safety and economy within their respective national jurisdiction.

A concerted effort was furthermore made to treat the extensive range of structures, actions, materials and design situations covered by its 58 parts in a consistent and unified manner. This is achieved to a large extent through a common basis of structural design as outlined in EN 1990.

The strengths of Eurocode also lie at the root of its principal weaknesses of being complicated and awkward to use in practice. Despite the comprehensiveness of its 58 parts, the technical contents is sparsely formulated, with any topic treated only once. This requires extensive cross referencing amongst a number of separate documents.

The addition of a national annex for each part containing national requirements such as safety and reliability; local conditions; and even certain preferences, raises the complexity of Eurocode to an even higher level.

The comprehensive scope of structures and conditions necessitates the use of extensive requirements, advanced models and inherent conservatism. The stipulations and procedures go well beyond those required for more conventional buildings and structures. The result is that the use of Eurocode is technically substantially more complicated. Whilst this is reasonable for ad-

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**Table 1 Summery of the 58 Eurocode parts**

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<td>EN 1999 Aluminium alloy</td>
<td>General rules</td>
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advanced structures, it proves to be cumbersome for the design of conventional structures. Although extensive guidance is given on reliability-based adjustment of safety levels, the inherent conservatism may also not be appropriate for general design practice.

EUROCODE AS REFERENCE FOR SANS 10160 (Draft)

The advances and complexities of Eurocode were carefully assessed when its use as reference in the formulation of SANS 10160 was considered. Specific needs for the South African standard included retaining the present scope of application, reliability levels and related economy of the resulting structures. The need for updated and extended requirements and procedures was however also clear. The elaborate and complex nature of Eurocode emphasised the need for concise formulation and procedures which are sufficiently simple for use in general design situations.

A number of inherent characteristics of Eurocode made it possible to use it effectively as reference to SANS 10160. Provision for the selection of nationally determined parameters (NDPs) allows adjustments to achieve required levels of reliability. The lack of full harmonisation between member states makes it possible to achieve corresponding performance in SANS 10160. Very importantly, the freedom of not being a member state makes it possible to carry only the selected procedures and values in the standard, without the need for awkward national annexes.

By selecting simplified procedures from Eurocode for the standard cases within the more restricted scope of SANS 10160, the South African standard has been formulated concisely. Sufficient consistency with Eurocode is maintained to enable the use of its advanced models for non-standard situations. It is however envisaged that this may require specialist input.

COMPOSITION OF SANS 10160 (Draft)

SANS 10160 (Draft) is formulated as a single standard, similar to SABS 0160-1989, but consisting of eight parts:
• The general basis for structural design is presented in the first part
• Four parts stipulate the actions which are included in the existing loading code: self-weight and imposed loads; wind actions, seismic actions; and design and crane-induced actions
• Three parts representing new topics: basis for geotechnical design and actions; thermal actions; and actions during the execution of the structure, which provides for actions during construction and erection

The layout of SANS 10160 (Draft) is summarised in table 2, together with an indication of the respective Eurocode parts that served as reference. An outline of the eight parts of SANS 10160 (Draft) is given below.

Part 1 Basis of structural design

This part presents the limit states design verification procedures as based on principles of structural reliability. It applies to the specified actions presented in Parts 2 to 8, but is also applicable to structural resistance according to materials-based design standards. It conforms to the principles of ISO 2394 through its reference to EN 1990. A formal reliability framework provides, inter alia, for the following:
• Reliability classes for structures, related to design procedures
• Differentiated limit states, including appropriate action combi-
Part 2 Self-weight and imposed loads
The format of EN 1991-1-1 was followed in the formulation of occupancy classes according to which minimum imposed floor loads were stipulated, with some simplification due to the fact that numerical values could be specified directly, as compared to the dual Eurocode system of symbolic specifications with values provided separately as nationally determined parameters.

The specified values were updated based on an extensive comparison of the SABS 0160–1989 values to those of international standards, with particular reference to EN 1991-1-1 and ASCE-7. The review provided indications that present values were significantly lower than those of the international standards. Moderate increases were generally applied in the revised specifications.

The provisions for imposed loads on inaccessible roofs were updated with an increase for the imposed loads on small tributary areas and a decrease of the imposed loads on large tributary areas, as based on an extensive investigation.

New provisions were introduced for actions induced by fork-lift trucks in buildings and for helicopter landings on building rooftops.

A comprehensive list containing the parameters and values for the calculation of the self-weight of construction materials and various stored materials is included in an annex to this part.

Part 3 Wind actions
Provisions for wind actions on buildings were based on EN 1991-1-4 General actions – Wind actions, but with substantial revision. The scope of structures is restricted to building with a height up to 100 m and quasi-static response to wind. The SABS 0160-1989 information on the South African wind climate serves as basis for the specification of free-stream wind speed and pressure whilst the EN 1991-1-4 pressure coefficients are used for the consequent wind actions on the building. Sufficient compatibility with EN 1991-1-4 is maintained to facilitate its use beyond the restricted scope of Part 3, by using the representation of the South African wind climate.

The main differences between the SABS 0160–1989 information on the South African wind climate and the EN 1991-1-4 procedures are concerned with the representation of the basic wind speed geographically and as function of height and terrain roughness. For this purpose the 3 second average values were converted to 10 minute average values, which are true for coastal sites but only approximately appropriate for inland areas where thunderstorms dominate in the generation of strong winds.

Calculation of peak wind pressures with height have also been adjusted to obtain the same peak wind speed pressure as with SABS 0160-1989 at equivalent conditions, including provisions for gust effects and the application of exponential wind profiles, as opposed to the logarithmic profiles for EN 1991-1-4.

Some adjustment is made to the set of terrain categories to improve its relevance and convenience. The roughest terrain category is omitted since such conditions do not occur in South Africa. Procedures are however included to provide for the effects of neighbouring structures and closely spaced buildings. Four terrain classes are then equally distributed across the range of the logarithm of the roughness dimension. This will omit the need for interpolation which is often necessary between Categories 2 and 3 of the present code.

An important adoption from EN 1991-1-4 is the extensive set of pressure coefficients for buildings and related structural configurations. These coefficients are considered to be a compilation of the most advanced information generally available, based on extensive wind tunnel testing.

Part 4 Seismic actions and general requirements for buildings
The resistance of buildings to earthquakes and rules for the design of such structures were substantially revised for incorporation into

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SANS 10160 (Draft). They are based on information from various other international standards, following the layout of EN 1998-1.

The provisions are restricted in terms of structural simplicity with redundancy; clearly established load paths and sufficient horizontal continuity; uniformity and symmetry of layout; sufficient ductility as provided by appropriate detailing. More advanced design requirements are required beyond these limitations.

Whilst the SABS 0160-1989 map on the reference ground acceleration from natural and mining induced events serves as point of departure, the incorporation of updated maps on the seismicity of South Africa is still under consideration. The acceleration response spectra are based on information from EN 1998-1.

Earthquake events are classified as accidental design situations not expected during the design life of the structure. The design objective is to limit the consequences rather than to prevent any damage, in accordance with Part 1. Seismic actions are consequently determined using the combination scheme for accidental actions. The importance class of the building is however taken into account in the specified seismic action.

More conservative behaviour factors which allow for the plastic deformation capacity and the over-strength of structural elements are however specified, with explicit requirements for detailing to ensure sufficient ductility.

Although requirements of structural design are specified in this standard which would logically fit into the materials design standards, such integral treatment of seismic actions and resistance against earthquakes is similar to the approach taken in EN 1998.

Part 5 Basis for geotechnical design and actions
The inclusion of Part 5 on geotechnical design and actions within the scope of buildings and similar industrial structures is an important extension to SABS 0160-1989. At the same time the specification of a geotechnical basis for limit states design is equally an important development in South African geotechnical practice. Owing to its unique nature the basis of geotechnical design is treated in Part 5 as a separate and special extension of Part 1.

Specification of geotechnical and geometrical data needed to obtain characteristic values for basic variables are presented for vertical earth loading; earth pressure; ground water and free water pressure; down-drag or uplift caused by ground movements; and deformations caused by ground movement.

Design verification procedures based on Design Approach 1 from EN 1990 and EN 1991-1 are specified, together with the appropriate partial factors.

Part 6 Actions induced by cranes and stationary machinery
The part on actions induced by cranes and stationary machinery makes provision for actions induced by overhead travelling bridge cranes on runway beams at the same level and actions induced by a limited range of stationary machinery causing harmonic loading.

For overhead travelling bridge cranes, provision is made for load models for hoisting and lowering of the pay-load, acceleration and braking of the crab, acceleration and braking of the crane bridge, skewing in plan of the crane bridge, misalignment of the crane wheels or crane gantry rails as well as the accidental design situation of impact on the endstops of the gantry. These models are derived from the mechanical behaviour of the crane and are less empirical.
than the provisions in SABS 0160:1989, resulting in improved reliability for the crane-supporting structure.

Guidance is provided for the combination of actions to be considered as a single action for the ultimate limit state, the serviceability limit state as well as for the purpose of assessing fatigue in the crane supporting structure. Informative annexes provide guidance for the classification of the cranes for the purpose of designing the supporting structure, guidance on estimating the value of the dynamic factor for the actions induced by a crane bridge travelling over a gap or a step in the gantry rails and guidance on the serviceability criteria for crane supporting structures.

Actions induced by stationary machinery are limited to machinery inducing harmonic dynamic effects in one or more planes on the supporting structure.

**Part 7 Thermal actions**
A new part on thermal actions on buildings is included as based on EN 1991-1-5. The characteristic maximum and minimum shade air temperatures for South Africa are based on the maps from TMH 7-1987 *Code of practice for the design of highway bridges and culverts in South Africa*. The procedures include the representation of actions resulting from thermal effects on buildings and structural elements and the determination of temperatures and temperature profiles, including radiation effects.

**Part 8 Actions during execution**
This new part gives principles and general rules for the determination of actions which should be taken into account during the construction or modification of buildings. Execution includes all activities carried out for the physical completion of the work including construction, fabrication and erection. It may be used as guidance for the determination of actions to be taken during structural alterations such as refurbishment and/or partial or full demolition. It provides for appropriate design situations and representation of actions; effects of the incomplete structure; and construction actions.

**CONCLUSIONS**
SANS 10160 represents a substantially revised standard for the basis of structural design and actions on buildings and similar industrial structures for South Africa. It is intended to form the basis for the implementation of the next generation of structural design standards in South Africa. It benefited greatly from the advances achieved by the final stages of the introduction of Eurocode which followed several decades of development.

**Harmonisation and Eurocode**
The close reference to Eurocode results in substantial harmonisation with international practice and thereby with the requirements of ISO 2394 *General principles on reliability for structures*. Freedom from the strict requirements for implementation of Eurocode member states allowed for significant improvement in effectiveness and simplicity of SANS 10160 as compared to nine separate relevant Eurocode parts with nine additional national annexes. Whilst the updated Eurocode procedures and models have substantially been retained, advanced Eurocode procedures can be applied for the situations beyond the more restricted scope of SABS 10160.

There is a significant tendency for specified actions resulting from SANS 10160 to be higher than that of SABS 0160-1989. However, this results from updated procedures and models, rather than systematic increases of actions and requirements. Although Eurocode contains conservative application of procedures, in addition to higher reference levels of reliability, a concerted effort was made not to incorporate any unwarranted conservatism in SANS 10160.

**Materials standards**
The use of SANS 10160 with the existing South African materials based structural design standards is made possible by maintaining existing reliability levels for SABS 0160-1989. The extended reliability framework should result in more consistent achievement of proper structural performance.

**Future South African standards**
SANS 10160 provides a suitable platform for future South African standards which are referenced to Eurocode. This need not only be limited to the present materials standards, but also to geotechnical design, steel and concrete composite structures with unified treatment of the composite materials, and structural aluminium alloys, where no South African standards exist at present.

The consistent treatment of structural fire design by Eurocode also provides an opportunity to introduce these advanced procedures to South Africa. This would consist of the extension of SANS 10160 to include actions on structures exposed to fire and the related requirements in the materials standards.

Similarly extension to actions and design requirements for specialist structures can be considered. The development of design procedures for water retaining structures is already underway to provide for the future withdrawal of BS 8007 which is generally used in South Africa. Bridge design is also an obvious candidate for this process.

**Procedure for standards development**
All these options will greatly benefit from the consistent Eurocode base for such future South African standards, since limited effort would be required to validate consistency with standards that are introduced incrementally. Such activities will also benefit from the experience of formulating SANS 10160 which is referenced to Eurocode. Such experience includes the way in which optimal use can be made of the Eurocode advances without the complexities of certain political requirements, such as elimination of trade barriers. It is found that the work involved in the selection of appropriate options and parameter values is of similar magnitude to that of Eurocode member states to formulate their respective national annexes. The benefit of concise and efficient formulation justifies the additional effort required to provide for restricted scope of application and reformulation of a South African standard.

**Acknowledgements**
The contribution of the members of the SAICE Working Group on the Loading Code is gratefully acknowledged, in particular that of the following:
- Professor Alan Kemp, the chairman over many years
- Dr Graham Grieve, the current chairman, who is overseeing the final distillation of the draft standard
- Peter Day, who played a key role as secretary and acted as champion together with Tim ter Haar, Professor Jan Wium and Dr Adam Goliger for various parts
- Dirk Loubser for the able implementation of SABS procedures
- Amanda de Wet for administering the various stages and versions of the document
ON 8 FEBRUARY 2008, a summit organised by the Joint Structural Division (JSD) and hosted by the South African Bureau of Standards (SABS) was held on the SABS campus in Pretoria with the objective of deciding the way forward for South Africa in response to the introduction of the Eurocodes in the countries of the European Union.

The summit was attended by representatives of major stakeholders in the materials, design and construction industries in South Africa. Ron Watermeyer (chairman of the SABS Technical Committee for Construction Standards and JSD committee member) chaired the summit.

Organisations represented included the Joint Structural Division of the South African Institution of Civil Engineering (SAICE) and the Institution of Structural Engineers (IStructE), the Geotechnical Division of SAICE, the South African Bureau of Standards, the Cement and Concrete Institute of South Africa, the Southern African Institute of Steel Construction, the Aluminium Federation of Southern Africa, the Institute of Timber Construction, the South African National Roads Agency, Eskom (the Electricity Supply Commission of South Africa), the Department of Public Works and the Chamber of Engineering Technicians, as well as a number of local authorities, five universities and several private companies.

BACKGROUND TO THE SUMMIT

The case for re-alignment of South African standards with the Eurocodes

South Africa has to a large extent based its structural design codes on those of the United Kingdom. The British standards will in due course all be replaced by the Eurocodes, leaving many South African standards without a basis. Given that the Structural Eurocodes are considered to be perhaps the most technically advanced suite of structural engineering design codes in the world today, a general feeling has been building up in the structural design fraternity in South Africa that the country should seriously consider aligning its standards in future with the Eurocodes, particularly since a number of countries outside the EU are also inclining towards the Eurocodes.

While such a shift in basis has substantial cost implications, it is recognised that South Africa may stand to benefit tremendously from the increased international competitiveness of its design and construction services, namely access to the EU market and regional markets in the Middle East, the Far East and in Africa. Of course it is acknowledged that adoption of the Eurocodes will expose the country to competition from the EU countries, but the benefits of alignment with the Eurocodes could outweigh the threat.

South African code developers also find the in-built flexibility of the Eurocodes potentially attractive. This would allow the country to retain desired national levels of safety or to choose values of geographic and climatic parameters that are better suited to the conditions of South Africa, while operating within a fairly general framework provided by the Eurocodes.

Recent code-related initiatives in South Africa

In 1998, the South African National Conference on Loading (SANCL) recommended that the South African loading code, SABS 0160:1989, should be revised. A SAICE working group was subsequently set up for this purpose, with representation from the Joint Structural Division, the Geotechnical Division and the various material sectors. This group would also act as a working group of the SABS Technical Committee for Construction Standards. The primary reference codes during the revision process were the four Eurocodes: EN1990 (Basis of Structural Design), EN1991 (Actions on Structures), EN1997 (Geotechnical Design) and EN1998 (Design for Earthquake Resistance).

The position of South Africa with regard to the Structural Eurocodes was discussed at the April 2007 meeting of the SABS Technical Committee for Construction Standards (TC 5120.61). It was reported that the SANS 10160 subcommittee were working on a revised South African loading code which would be compatible with the Eurocodes. It was agreed that a strategic decision needed to be taken on whether to adopt or adapt the Eurocodes for structural design in the various materials. The chairman was tasked to get a group of stakeholders together to discuss the issues and make recommendations to the Technical Committee.

The University of Cape Town convened a series of one-day Eurocode symposia for industry in July and November 2007 to introduce South African structural engineers to the Eurocode system and familiarise participants with the provisions of EN1990, EN1991, EN1992 and EN1993. The general feeling at these symposia (attended mostly by principals of consulting firms and decision-makers
from the construction industry) was that South Africa needs to go the Eurocode way, but the main uncertainties centred around how that will happen and when. Clarification was also needed on the future of those specialisations that opted not to go the Eurocode way. It was noted that some efforts were already under way in South Africa to revise standards along the lines of the Eurocodes, but it appeared that there was no general framework yet for a systematic switch to a Eurocode basis, neither was there a common national policy providing guidance on the usage of the Eurocodes.

It is against the above background that the committee of the Joint Structural Division in South Africa decided to organise, with the support of the SABS, a national summit on the Eurocodes where the various stakeholders in the industry would be able to express their views on the issue.

EXPECTED SUMMIT OUTCOMES, SPEAKER BRIEFING AND PRESENTATIONS

South Africa is different to the UK and other EU nations in that it is not obliged to adopt the Eurocodes. Accordingly, each material sector (concrete, steel, masonry, timber and aluminium) and the specialised sectors (bridges, containment structures, geotechnical design and seismic design) needed to debate on whether to (i) adopt the Eurocodes and produce South African national annexes for the various parts, (ii) develop South African national standards based on the Eurocodes (that is, adapt the Eurocodes), or (iii) update existing South African national standards independently of the Eurocodes.

The speakers on the various sectors were briefed to address the following points:

- What are the issues which drive code development in South Africa?
- Is there a need for revising current codes, and if so, why?
- Which option (adopt/adapt/reject Eurocodes) is favoured?
- What are the benefits associated with the preferred option?
- What are the resources and expertise available for adopting/adapting the Eurocodes?
- What is the estimated timeframe for implementation of the preferred option?
- What are the implications on current material specifications of adopting a Eurocode?

The issue of loading required special consideration, since work on revising the existing South African Loading Code (SANS 10160) along the lines of the Eurocodes EN 1990 (Basis of Design) and EN 1991 (Actions on Structures) had already begun a few years ago, and is approaching the final stages. Here the questions which needed to be answered were:

- What is the relationship between the proposed revision of SANS 10160 and EN1990/EN1991 (what are the fundamental differences)?
- Why was it necessary to revise SANS 10160 based on EN1990/EN1991, instead of adopting EN1990/EN1991 with SANS 10160 reworked into a South African national annex?
- What is the remaining time for the publication of the revised South African Loading Code?

Speakers and their presentations (in the order of the programme) were as follows:

- Welcome and introductory remarks: Ron Watermeyer, summit chair and chair of SABS Technical Committee for Construction Standards
- The case for the Eurocodes for South Africa: Alphose Zingoni: University of Cape Town and JSD committee member
- The standards development process in terms of South Africa’s WTO obligations: S Adam, SABS
- Geotechnical codes: Peter Day, SAICE Geotechnical Division and SANS 10160 Working Group
- Aluminium codes: Tony Paterson, Aluminium Federation of Southern Africa
- Concrete codes: Jan Wium, University of Stellenbosch and SANS 10100 Subcommittee
- Steel codes: Hennie de Clercq, Southern African Institute of Steel Construction
- Containment structures codes: Alphose Zingoni, University of Cape Town and JSD committee member
- Bridge codes: Edwin Kruger, South African National Roads Agency
- Masonry codes: Fred Crofts, Tshwane University of Technology and JSD committee member
- Timber codes: Victor Booth: Institute of Timber Construction and JSD committee member
- Loading code and basis of design: Peter Dunaiski, University of Stellenbosch and SANS 10160 Working Group
- Earthquake codes: Jan Wium, University of Stellenbosch and SANS 10160 Working Group
- Discussion and resolutions: Ron Watermeyer and Alphose Zingoni

SUMMIT OBSERVATIONS, OUTCOMES AND CONCLUSIONS

The main observations, outcomes and conclusions of the summit may be summarised as follows:

- Broadly speaking, four areas need to be covered by codes: buildings; bridges; containment structures; foundations. South African national standards (as published by the South African Bureau of Standards – SABS) currently cover only buildings. Bridges are covered by the standards of the South African National Roads Authority. There are no South African national standards for geotechnical design or for containment structures.

- It was considered justifiable and appropriate that a South African national standard based on EN1990 (Basis of Design) and EN1991 (Actions on Structures) has been under development. The revised standard (SANS 10160) was scheduled for publication at the end of 2008, and would cover basis of design, self-weight and imposed loads, wind actions, seismic actions, geotechnical actions, thermal actions, actions induced by cranes and machinery, and actions during execution. The new SANS 10160 is Eurocodes compatible and can be used with the various material Eurocodes and with the geotechnical Eurocode.

- The concrete material sector opted for generally adopting EN 1992 (EC2: Design of Concrete Structures) for buildings, with some aspects possibly needing adapting. The estimated implementation time was two years.

- The geotechnical sector were in favour of adopting EN1997 (EC7: Geotechnical Design) as soon as the revised Eurocode-compatible SANS 10160 has been published. Implementation could therefore start by the end of 2008.

- The steel sector, while wishing to adopt the Eurocode for steel (EN1993) in the longer term, see no urgency to adopt this for now, since the South African steel codes have been updated fairly
recently. Moreover, they would like to follow the implementation of EN1993 in the UK over the next few years.

The masonry and timber sectors are also in favour of adopting the Eurocodes in the longer term, but see no urgency to do so now, and would also like to follow the process of implementation in the UK.

The aluminium sector are also in favour of adopting EN1999 in the longer term (5–10 years).

For containment structures, adoption of the Eurocodes was accepted as the best way forward. The absence of South African standards covering the design of facilities like liquid-retaining concrete structures, metal silos and tanks justifies a quicker adoption of the relevant parts of the Eurocodes. However, it is acknowledged that any national annexes required in this regard will take a few years to compile, and implementation will vary from a minimum of three years in the case of liquid-retaining concrete structures, and longer (six to eight years) in the case of steel silos and tanks. Appropriate working groups need to be set up for this.

The bridges sector considers it too early to decide on whether to adopt or adapt the Eurocodes, and will continue to use TMH7, Code of Practice for the Design of Highway Bridges and Culverts in South Africa, for the foreseeable future. However, they acknowledge that the current standard for actions on bridges needs to be revised, and would like to see the symbols used in bridge design aligned with those of the Eurocodes and compatible with the building codes.

Overall, while most industry sectors supported the adoption of the Eurocodes, there is no particular urgency to adopt the Eurocodes right now, and South Africa would do well to lag behind the implementation timetables for the UK in order to benefit from the supporting documentation, guides and software that are being developed in that country to facilitate the effective implementation of the Eurocodes.

There is an urgent need for the South African Bureau of Standards to approach CEN (the European Standards body) to obtain clarity on the extent to which the material of EN documents may be incorporated into South African national standards. This is particularly so with regard to the revised South African Loading Code (SANS 10160), which draws substantially on EN 1990 (Basis of Design) and EN 1991 (Actions on Structures). The current CEN-SABS agreement (2001) may have to be revised.

In conclusion, the Eurocodes Summit was considered to have been a great success, and South African industry now has a clearer sense of direction. While implementation timetables will vary considerably (from one to two years to as much as eight to ten years), most sectors in South Africa have agreed the Eurocodes is the way to go, and the next few years will see increased activity in this regard.

The full summit report may be downloaded from www.jsd.co.za or www.jointcivils.co.za.
I JOINED WORLD Vision International as Director, Global Supply Chain Management in April 2007.

Although I am working from my home office in Pretoria, I am based in Monrovia, Los Angeles. My background is in transportation engineering and transport economy, but I have been specialising in logistics and supply chain management for the last 17 years.

In 2006, World Vision served more than 100 million people and worked in 97 nations. More than 3 million children benefited from child sponsorship while World Vision employed 23 000 staff members and raised US$2.1 billion in cash and goods for its work.

The scope of supply chain management in World Vision is massive and ranges from emergency relief assignments to long-term development projects. The user group of the World Vision supply chain include:

- Food distribution (both emergency relief and long-term feeding schemes)
- Relief and emergency support (shelter, water and sanitation, food and medical)
- Global pre-positioning of commodities, products and equipment
- Development projects (building materials for schools, clinics and homes)
- Gifts-in-kind storage and distribution (medical products, clothes, educational materials, utensils, etc)

It is clear that through specialist applications such as water and sanitation, transportation, structures and project management, civil engineering is intimately involved in relief and emergency work.

My responsibilities include the development of a global supply chain management strategy for World Vision that consists of process guidelines for planning, sourcing (procurement), delivering and returning (transport, warehousing and inventory management) commodities, products, materials and services in all...
the countries where World Vision operates. This implies that I need to travel extensively and I was privileged to be able to visit Banda Aceh, where the tsunami disaster struck in December 2004. Photos 1–3 were taken in May last year and show the force of destruction still clearly visible. Photo 1 shows a fishing boat that landed on a home and is used today for accommodation as part of the home; the two other pictures are of the offshore power plant that came to rest about 3 km inland from the shoreline.

We visited some of the housing reconstruction projects where the infrastructure still needs significant investment to be restored to former functionality. Photo 4 shows the access road to a large reconstruction project, using very rudimentary timber support across a channel.

Photo 5 is my favourite. I just could not pass the water tank with our flag on the side! It was so good to see evidence of our South African support in these sad conditions.

On another occasion, towards the end of May last year, I was visiting a development project in Mumbwa, Zambia, close to the Kafue National Park. We observed protocol and visited Chiefteness Kabulwebulwe before we entered the area. What a magnificent opportunity to sit at her feet representing World Vision! I asked her what she would like as a present from us, and she responded with a small request – she would like to have a bicycle for her messenger, because it takes too long to reach all her people on foot.

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It remains great to be a civil engineer and to experience the opportunity to ‘build bridges’, literally as well as figuratively!
A FLYING VISIT to our members in Swaziland who are active in the Swaziland Association of Architects, Quantity Surveyors and Engineers, and from there to Mozambique, was exhilarating, interesting ... and nerve-wracking.

We started off at Manzini with host John Resting in the driving seat and were joined by Arthur Belsey. He is the project director for a major SWADE project.

A fascinating trip followed as we were treated to a visit to a R1,5 billion agricultural project for small farmers, that will provide irrigation water from the Usuthu River.

What made this project so interesting for us, is that it contains many engineering applications, from a stone rubble masonry weir to sophisticated intake structures and a 21 km canal, and inverted siphons. The canal ultimately discharges into a reservoir being formed by building a roll-crete dam, a rock-fill dam and a low rise saddle-earth dam.

Many aspects were taken into consideration and local geology played a major role. The rock from the spillway excavation is used next door for making roll-crete, the clay is mined almost next to the clay core rock-fill dam, so waste and transport of material is very limited. I expressed the view that one seldom sees so many engineering components in one project and that this makes it a perfect field trip, not only for career guidance and students, but also for seasoned engineers.

Our interaction with the Swaziland Association of Architects, Quantity Surveyors and Engineers, which is chaired by Nhlanhla Maphanga, resulted in an invitation for them to sign the AEF Protocol so that our relations can be formalised. CPD, registration and related matters are high on their agenda.

The visit was concluded with a breakfast meeting with SAICE members and leaders from government. The need for a final professional registration system again came to the fore, as did skills transfer challenges, CPD and even joint ventures with South African companies. They are asking why it cannot be made easier from them to export their services to South Africa in the same way as we support other countries.

And then our woes began ...

Booking luggage through from Manzini to Maputo via Johannesburg resulted in luggage only arriving seven hours after we had landed, and after lots of hassles. But there is more ...

My passport was too full to the liking of the Mozambique officials, so I landed up in the office of the immigration officer, with resulting officialdom hassles. And still more ...

On the way to the hotel we were accosted by two grey-uniformed policemen...
with big guns. They claimed that I had done ‘something wrong’ in terms of traffic rules. But they said that I could fix it quickly by paying a couple of thousand. No, I replied, I would rather go to the police station. Fortunately I succeeded in getting Neil to the hotel first, asking him to phone with advice from the hotel. While chauffeuring the two policemen around Maputo, they were reducing the asking price as we went along. When Neil phoned with advice garnered from hotel staff, Afrikaans came in rather handy. I then told the policemen that the call had been from my lawyer. This unsettled them and they asked me to stop where they had been hiding in the bushes in the first place. There they got out, feeling very sorry for themselves for not even getting a drink out of me.

Our meeting with Ordemo des Engenheiros president, Alvaro Carmo Vaz, and his wife, Isabel, together with members of that institution, was a wonderful opportunity to exchange ideas.

And after a restless night, some more hassles and bother with tickets and stuff, it was time to go home sweet home to Johannesburg and Durban. Home is not so bad, after all ...

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<td>Roland Prukl</td>
<td>Dawn Hermanus <a href="mailto:dhermanus@saice.org.za">dhermanus@saice.org.za</a></td>
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<td>Tony Lydall</td>
<td>Sharon Mugeri <a href="mailto:Cpd.sharon@saice.org.za">Cpd.sharon@saice.org.za</a></td>
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<td>Greg Parrott</td>
<td>Sharon Mugeri <a href="mailto:Cpd.sharon@saice.org.za">Cpd.sharon@saice.org.za</a></td>
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<td>Melissa Wheel <a href="mailto:wisa@wisa.org.za">wisa@wisa.org.za</a></td>
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<td>19–20 May – Cape Town</td>
<td>Geographical Information Systems SAICEtr07/00130/09</td>
<td>D van As</td>
<td>SARF <a href="mailto:sarfuse1@acenet.co.za">sarfuse1@acenet.co.za</a></td>
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<tr>
<td>2–4 June – Gauteng</td>
<td>Environmental Management for the Roads</td>
<td>S Ballot</td>
<td>SARF <a href="mailto:sarfuse1@acenet.co.za">sarfuse1@acenet.co.za</a></td>
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<tr>
<td>22–23 July – Gauteng</td>
<td>Basic Construction Estimating &amp; Planning SAICEcon06/00160/09</td>
<td>Phil Watson</td>
<td>Sharon Mugeri <a href="mailto:Cpd.sharon@saice.org.za">Cpd.sharon@saice.org.za</a></td>
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<tr>
<td>23–27 June – Johannesburg</td>
<td>Design of Masonry Structures</td>
<td><a href="http://www.wits.ac.za/enterprise">www.wits.ac.za/enterprise</a></td>
<td>Prof. HC UZOEGBO <a href="mailto:Uzoegbo@wits.ac.za">Uzoegbo@wits.ac.za</a></td>
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<tr>
<td>22 June – 19 July</td>
<td>Construction Management Programme SAICEcon07/00199/10</td>
<td><a href="http://www.cpm.sun.ac.za">www.cpm.sun.ac.za</a></td>
<td>Alett Slabbert 021 808 4363 <a href="mailto:alett@sun.ac.za">alett@sun.ac.za</a></td>
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<tr>
<td>27–31 October – Gauteng</td>
<td>Tailings Course 2008 SAICEstr07/00232/10</td>
<td>Beric Robinson</td>
<td><a href="mailto:beric@fraseralexander.co.za">beric@fraseralexander.co.za</a></td>
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<tr>
<td>24–26 November – Cape Town</td>
<td>2nd International Conference on Concrete Repair, Rehabilitation and Retrofitting <a href="http://www.civil.uct.ac.za/icccrr">www.civil.uct.ac.za/icccrr</a></td>
<td><a href="mailto:icccrr@eng.uct.ac.za">icccrr@eng.uct.ac.za</a> +27 21 689 7471</td>
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