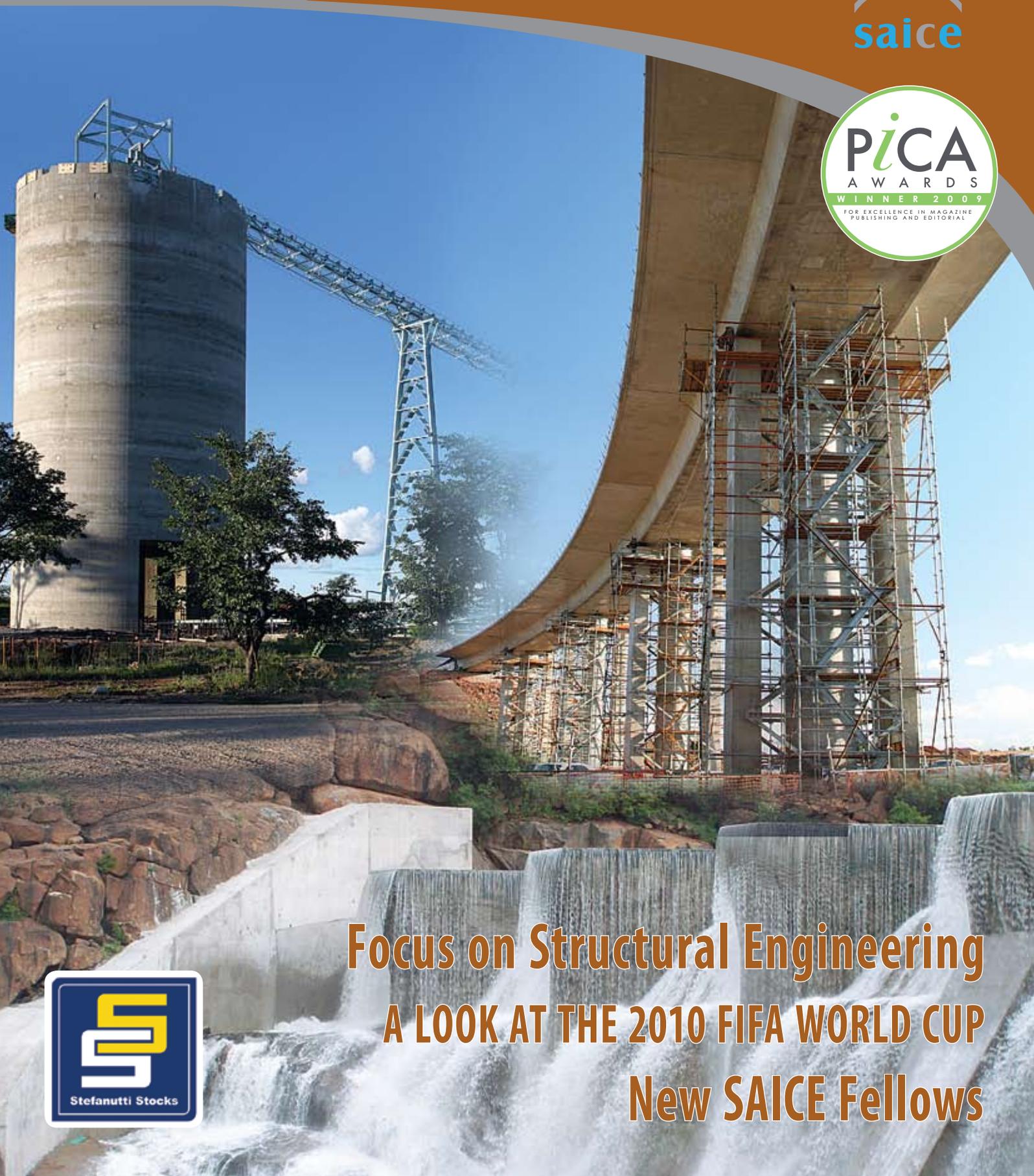


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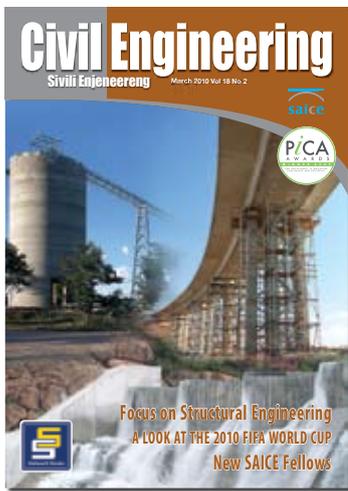
Sivili Enjeneereng

March 2010 Vol 18 No 2



Focus on Structural Engineering
A LOOK AT THE 2010 FIFA WORLD CUP
New SAICE Fellows





ON THE COVER

Stefanutti Stocks Civils, a division of Stefanutti Stocks (Pty) Ltd, are proud of their heritage in constructing reinforced concrete structures in the mining, infrastructure, water and industrial sectors throughout southern Africa. Two such challenging projects are the R21 link bridge over the N1 in Pretoria and the rehabilitation of the Bospoort Dam



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ON THE COVER

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Bospoort Dam

SOME 18 MONTHS DOWN the line, the rehabilitation of the Bospoort Dam for client DWA (Department of Water Affairs) is complete. The Bospoort Dam is located on the Hex River in the North West Province, approximately 15 km to the north-east of the Rustenburg Dam. It is dedicated to the supply of primary water to the municipality of Rustenburg. The dam has been rehabilitated in line with safety requirements as part of the DWA's *Dam Safety Rehabilitation Programme*.

Design work and supervision for the project was conducted by a joint venture of Goba and ARQ. Major work was required at Bospoort, a Category III dam, where significantly inadequate spillway capacities were evident. The unreliable gated spillway was replaced with a reinforced concrete labyrinth, while an additional new spillway was also constructed in a saddle on the right flank. To increase the marginal stability of the existing concrete gravity structure, buttresses were incorporated into the

labyrinth construction. As the existing embankments also required significant rehabilitation, the necessary repairs were incorporated in the raising design, providing a cost-efficient solution.

The construction work was carried out by Stefanutti Stocks Civils, Stefanutti Stocks Geotechnical and Stefanutti Stocks Earthworks, all divisions of Stefanutti Stocks (Pty) Ltd. The construction work included the removal of the existing spillway gates, the demolition of the dam spillway crest, non-overspill crest (NOC), piers, decks, slabs and retaining walls. The demolition work was a critical operation, and had to be performed with extreme caution to ensure that the existing post tension cables of the dam were not damaged.

Whilst work was under way, it was imperative to control the water level of the dam in order to construct 80% of the work. This had to be done without limiting the water supply to the Bospoort Water Works and the community downstream of the dam. Construction works were carried out in

a sensitive environment, necessitating appropriate care from the site team.

A total of 15 000 m³ of concrete was placed on the dam wall during the reconstruction operation, which included the reconstruction of labyrinth walls, buttresses, outlet works, NOC and auxiliary spillway, with most of the work taking place 26 m above ground. A total of 75 000 m³ of mostly rock was excavated for the new concrete saddle spillway some 75 m long, for which curtain grouting was required as well.

Three saddle embankments were reconstructed, and a new stabilised toe on the upstream side of the structure was formed through the dumping of material to approximately one third of the height of the structure. New rip-rap protection was bedded on the upstream

- 1 Construction work taking place during the rehabilitation of the Bospoort Dam
- 2 Evening descends on the team constructing buttresses and labyrinth spillways at the Bospoort Dam



face to replace the existing protection, while a new gravel protection layer was installed on the downstream face.

The rehabilitation of large structures, such as dams, provides civil engineers with tremendous satisfaction when these structures are restored to beyond their former glory. This was particularly evident when the project team members were rewarded for their efforts with an overspill of the new spillway before the end of the construction phase.

Dam building remains one of those special things that civil engineers do!



► INFO

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③ An aerial view of the Bospoort Dam in the Hex River north of Rustenburg in the North West Province

④ The project team's ultimate reward – to see the newly rehabilitated Bospoort Dam spillway in action prior to the end of the project



JOINT STRUCTURAL DIVISION



The Institution
of Structural
Engineers

Chairman's report on JSD 2009 activities

DIVISION CHAIRMAN APPOINTED TO THE IStructE COUNCIL

In the previous report we informed members that the division chairmen were to be included in the IStructE Council. Hence I attended three Council meetings in London. There is absolutely no doubt that this concept has improved communication and cooperation between London and the JSD.

Some of the issues that require reporting back from Council are the following:

- The recession in the UK is having a profound influence on the finances available to IStructE. Numerous belt-tightening steps have been taken and if everything goes according to plan a small loss or break-even situation should be achieved for the 2009 financial year. To this end the JSD did not call up the funding budgeted for us for 2009. We have accordingly dug into our savings but I am sure we all agree that a financially strong Institution is vital for the future of structural engineers.
- The new CEO of IStructE, Martin Powell, took up his post towards the end of February 2009. He arrived to find the tough international financial situation having its effects on IStructE. He has made numerous

changes which I am sure will bode well for the future.

- Stuart Kitching, long-serving company secretary has now retired. His place was taken by Dr Sue Doran. Sue's position as technical director was filled by Sarah Fray.
- The Institution is now aware that it is an international organisation based in the UK. Rob Young has been the driving force behind an "international interest group meeting" (held before Council meetings). This gathering is still on an informal basis, but their discussions and suggestions do go forward to the Executive Board for consideration and action. This should benefit the non-UK membership in the future.
- I have joined the Institution's Standing Committee on Implementation of Eurocodes as a corresponding member (every division has been asked to provide one such member). In this way we will keep up to date with developments at the Institution in this regard. The relevant findings will be forwarded to the interested "material" working groups.
- Any JSD member who would like to become involved in any of the IStructE committees or interest groups as a corresponding member

should contact the Chairman or Secretary. The information about these groups is also on the IStructE website (www.istructe.org).

TUESDAY AFTERNOON TECHNICAL TALKS

The Tuesday afternoon technical talks continue to be well attended. The talks are worth 0.15 CPD points for attendees. Typically between 40 and 90 structural engineers regularly attend. We look forward to more and more new faces each month. John Duncan is doing a sterling job organising these talks. Please contact him if you have any suggestions for topics or speakers (011 463 1706 – john.duncan@xsteel.co.za).

JSD ACTIVITIES REGARDING PROFESSIONAL STATUS

Unfortunately the IDoEW proposals submitted to the SA Council for the Built Environment have been rejected. We hope that agreement on this document can still be reached.

Nevertheless, the important work of getting a Code of Practice written continues and Rob Young is still chairman of the drafting committee of the Structural Code of Practice through the auspices of ECSA. This has been written in parallel with the Geotechnical Code of Practice. The two documents are very similar with

regard to background and conceptual issues, the structure of the documents, chapters, and numbering. In this regard I quote from Rob Young's most recent report to the JSD committee:

"A Steering Committee meeting was held at ECSA offices on Thursday 22-10-09 to review and discuss the Structural Engineering and Geotechnical Engineering Codes of Practice as drafted to date. The principle and formatting of the documents was approved in general, but with certain reservations. There is an overall hold on final approval, due to the 'Identification of Engineering Work' document (to which our Code refers as starting point) not having been accepted yet."

As previously reported I truly believe that once the process is completed our efforts will go a long way to uplift our structural engineering profession to levels commensurate with the risks we take and the life-saving role we play.

THE FUTURE OF THE "PROFESSIONAL COUNCILS"

The Minister of the Department of Public Works has withdrawn the new SA Council for the Built Environment legislation. It is not clear what the future of the legislation will be.

SANS 10400 DEFINITION OF COMPETENT PERSON

Ron Watermeyer and Victor Booth continue to represent JSD interests on the S59 technical committee involved with (amongst other issues) the updated version of the National Building Regulations and

their interpretation. Ron no longer chairs the committee. At this point in time it appears as if certain parties wish to review the definition of competent person. This has resulted in a possible total review of much work that was previously thought to have been completed. The timetable for the release of the new document is unknown.

JSD FINANCES

Following the continued tremendous financial support in the form of sponsorships from the following companies, the JSD finances are in good shape:

Arup	Cadex
Jones and Wagener	Mackenzie Mackie
Roymec	Semane
SLR	Tony Smith Assts
UWP	

We are not a financial burden on London, and have also been able to get some income from the sale of damaged IStructE books.

YOUNG PERSONS ACTIVITIES

In line with IStructE and SAICE the JSD has made a move to involve younger engineers in our activities. To this end Frederica Herbert from KZN has become a member of the committee. Frederica is trying to set up some activities and a series of lectures for young engineers in the Durban area.

ON THE LIGHTER SIDE

The annual banquet was, as usual, superbly organised by Steve and Pat Mackie, and was once again held at the Johannesburg Country Club. It was

attended by about 120 members and their guests. Light entertainment by way of music from violinist Christina Rodrigues made for a relaxing and entertaining evening.

THE WAY FORWARD

Tony Aimer has now taken over as new JSD chairman and we wish him every success for his two-year reign. Most of the issues under discussion are ongoing, but I am sure Tony has some particular items that he will be driving. Please be reminded that the JSD represents you and you are most welcome to attend any of our meetings if you have an issue to discuss or if you are just interested in joining our activities. Feel free to contact Tony Aimer (011 793 5968 – taimer@zanet.co.za) or Steve Mackie (011 678 1759 – stevemackie@icon.co.za) in this regard.

THANK YOU

I would like to thank all members of my committee for their interest, support and hard work over the past year. To Rob, Mick and Tony thanks for all the travelling effort to attend the meetings. In particular my grateful thanks to Steve Mackie for all the hard work that goes into performing his secretarial duties, but especially to him and Pat for the great show they put on for the banquet. Thanks to Victor Booth and his bookkeeper for getting our financial reporting into shape. And thanks to Tony Aimer for his close cooperation during the year. □

First international conference dedicated to mining structures a great success

THE WORLD-RECOGNISED standard for mining structures, SANS 10208, was put under the spotlight at a special seminar which was the forerunner to the Southern African Institute of Steel Construction's (SAISC) conference on 'Structures for Mining and Related Materials Handling'. The conference, the first of its kind in the world, was held at Sun City, South Africa, from 9 – 12 November 2009.

SANS 10208 deals with the loading conditions and design requirements for headgears, sinking stages, conveyances and structures associated with shafts.

According to Dr Geoff Krige, Engineering Manager (Structures) at Anglo American, and chairperson of the SANS 10208 Committee, the standard has undergone significant revisions in the past eight years. The seminar focused on these revisions.

"For historical reasons, the most significant changes have been in the area of incline shafts," says Krige. "While South Africa's expertise has largely been developed on gold mines where the reefs are typically very steep – 20 to 25 degrees – the burgeoning

platinum and coal mines are much less steep – 12 to 15 degrees – facilitating greater use of inclined shafts and conveyances, and making the appropriate revisions to and the updating of the standard necessary."

Krige says there has been significant overseas interest in SANS 10208. "The Australians are currently looking at adopting large portions of it and I hope to visit Standards Australia soon to ascertain the progress on this. The Canadians are using the concepts outlined in SANS 10208 quite widely and we hear that the Americans are also keen on using it."

Apart from running the seminar, Krige presented two papers at the conference. One deals with Anglo American's specifications for the use of conveyances. "As SANS 10208 deals with the design of conveyances and not with how to use them, Anglo American has developed detailed operational specifications, which I deal with in this presentation."

The other paper concerns loading control for big mining machines such as stackers and reclaimers. "Anglo American has found some gaps between emer-

gency load conditions and what the standards specify, and this paper deals with these gaps," Krige says.

Twenty-three papers were presented at the conference. Four of the papers were by visitors from Australia covering a wide range of topics – from a new coal load-out terminal at Wiggins island to an interesting approach to refurbishing a reclaimer.

The South African speakers were the who's who of engineers specialising in the structural design of mining projects. They covered almost every aspect of the mining industry, such as shaft and conveyance design, headgear design, latest methods of surveying existing mining structures, and many other interesting topics.

The audience unanimously demanded a repeat conference in three years' time, possibly to be held in Perth or Brisbane.

Copies of the proceedings are available from the SAISC.

▶ INFO

SAISC

011 726 6111

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STRUCTURAL ENGINEERING

Steel Awards 2009 a splendid harvest

The Southern African Institute of Steel Construction receives more and more entries for their annual steel awards. With over seventy entries received for 2009, new records were once again set

EXPORT CATEGORY

We South Africans tend to think of Madagascar as that largish island off Mozambique that is a great place to have a holiday, but Fort Dauphin on the south-east coast of Madagascar is a

challenging location. So building a state of the art dune mining project in this backwater where there are no nearby port facilities, engineering workshops or even a hardware store where one could buy simple odds and ends like screwdrivers clearly necessitated some very special planning and logistics for the successful completion of the project.

1 Rio Tinto QMM Ilmenite Project, Madagascar – winner of the Export Category



Export discipline and controls of an exceptionally high standard were indeed on full display at the Rio Tinto QMM Ilmenite Mine which made the project such a worthy winner in the Export Category.

The bulk of the plant is built on pontoons that float in man-made lakes to enable the dune sand to be pumped in slurry form. First line beneficiation takes place on the pontoons. The waste sand is thus pumped straight back to where it came from after separating out the minerals. In this instance the pontoons were purchased in China but the rest of the steelwork and structures came from South Africa.

The plant towers above its surroundings to a height of 33 m and is anchored against severe wind conditions by four large winches at its corners, which also render it manoeuvrable in the extraction pond. The statistics for this almost surreal project speak for themselves with the plant boasting the following material tonnages: pontoon mass 1 888 tons, structural steelwork 1 582 tons, equipment 1 347 tons, material and water 2 800 tons – giving the plant a total mass of 7 617 tons under normal operating conditions.

Madagascar has unique fauna and flora not found anywhere else, so apart



from the significant logistic and construction challenges experienced, great care was also taken to protect this area's sensitive ecology.

TUBULAR STRUCTURES CATEGORY

For many years now the Association of Steel Tube and Pipe Manufacturers has sponsored this award. In our entries this year were many of the soccer stadiums, almost all of which had large bore tubes as main members.

Other entries included an indoor swimming pool for the Blue Down suburb in Cape Town, a 36 m clear span upside-down toblerone profile girder over the SciBono science museum, and an upmarket 'Patio Warehouse' store for garden/patio furniture, all showing off the many ways in which tubes can be used both architecturally and for engineering.

But it was a 'chic little number' built over the new Galleria arcade at the Melrose Arch shopping mall that truly stole the judges' hearts. In any ordinary year, without all the special stadium structures, this structure would have been an incredibly strong contender for overall winner.

The project is one of cooperation, brain-storming and competence leading to this very special result. To start with there were no architectural drawings, but some think-tank brainstorming conceptual ideas grew into this project. It started with a 'fishnet stocking' concept for the roof (just a portion of the curved part), which then developed into a structure by playing around with one of those expanding hotplate table-top savers, knocked into constructable panels that would stand up long enough to get all the site welding done to turn it all into a stable steel structure.

Oh, and by the way, make the whole thing go around a corner, and cover it with glass. To really make this into the exceptional project it is, needed every player in the team to pull beyond his



2 The Galleria roof in Melrose Arch, Johannesburg – winner of the Tubular Structures Category

3 The Royal Bafokeng Sports Palace upgrade, Rustenburg – winner of the Technical Excellence Category

4 The 'room with a view' reception area in Gottlieb Distribution Centre – winner of the Architectural Structures Category

weight. This project would stand proud anywhere in the world. Well done!

TECHNICAL EXCELLENCE CATEGORY

Upon being interviewed about his experience as a Steel Awards judge, representing the Institute of Architects, Hugh Fraser commented, "As an architect I dream up the projects, but it is the engineers who have to make it all happen." Indeed!

To stand out in a category which included entries such as the control tower at the new King Shaka Airport, which was assembled at the base of the tower and then strain-jacked up to level, or a 'small' modification to an existing telecommunication mast to incorporate a fan-driven electrical generator, or a new jetty in Port Elizabeth harbour built on and saving some existing piers, you have to be very special.

And so it was that the Royal Bafokeng Sports Palace (soccer stadium et al) upgrade stood out amongst its peers. This is an extension to an existing stadium and I defy anyone who

did not know the old stadium to identify the join line and the new parts.

The upgrade increased the ground capacity from 39 000 to 45 000 seats. But the really difficult technical parts relate to the steelwork at roof level – the structural nodes at the top of the conical-shaped columns which join the roof rafters and various bracing systems together. Each of the 32 different nodes has seven different 400 mm diameter pipes each intersecting in a common centroid. The workmanship is superb.

ARCHITECTURAL STRUCTURES CATEGORY

The winner in this category comes as no surprise. Architects Elphick and Proome, who have won three awards in the last four years, are up there again with a very special office building and warehouse for a clothing manufacturer in Durban. Their imaginative use of colour, steel and concrete has turned this facility into a workplace with an ambience par none.

The judges were unanimous that the building housing the offices and

To stand out in a category which included entries such as the control tower at the new King Shaka Airport, which was assembled at the base of the tower and then strain-jacked up to level, or a 'small' modification to an existing telecommunication mast to incorporate a fan-driven electrical generator, or a new jetty in Port Elizabeth harbour built on and saving some existing piers, you have to be very special

distribution centre for the Gottlieb Group was an outstanding illustration of the aesthetic use of structural steel in the development of industrial buildings. "This pioneers a new generation of industrial buildings," they said.

"The first impression when arriving at the premises of Gottlieb House is one of a structural steel warehouse, situated high on the natural hills of KwaZulu-Natal, designed by an architect who loves the aesthetic feel of exposed steelwork and is great at making it work," the judges said.

The 'room with a view' reception is an excellent example of exposed steelwork complemented by coloured and clear glass in diagonal panes. This area also has a striking steel staircase, illustrating the architect's appreciation for using the right material in the right place.

The judges stressed that, apart from its aesthetic and functional brilliance, it was the pioneering use of steel in an industrial environment that won this project the prize.

Should other industrial enterprises follow the example of the Gottlieb offices and distribution centre, the entire aesthetic face of South Africa could undergo a radical change," they concluded.

LIGHT STEEL FRAME BUILDING CATEGORY

It has only been three years since the introduction of this product to South Africa. The industry is now organised, has a SANS code of practice to ensure quality, has a vibrant team of contractors who are doing much to train and develop skills to ensure top quality, good finish, long lasting, well insulated and comfortable buildings to live in.

This is an ideal system for building in remote places like the Mozambique coast, the eastern Free State, or even more built up locations like Durban airport, because transport costs are minimal compared to traditional materials, and waste removal is next to nothing on completion of the projects.

In a year when the number of entries in this category grew significantly,

5 One of the three winning light steel frame houses at Breedezicht

6 Light steel frame house being erected at the Breedezicht Estate in Witsand on the Garden Route – winner of the Light Steel Frame Building Category





it was not a single house that stood out from the rest, but three houses in the same estate – the Breedezicht Estate in Witsand on the Garden Route. These houses best epitomise everything that is good about the system, showing professionalism comparable to anywhere in the world. Using three totally different levels of expense when it comes to the finishes, but all displaying the high quality of presentation that can be achieved with the method, these houses display just how flexible the method can be.

Breedezicht clearly demonstrates how the Light Steel Frame Building system produces homes of exceptional strength and solidity whilst affording easy, fast and accurate installation. Surely this is the way of the future to high-quality reasonably priced mass production housing solutions.

RESIDENTIAL CATEGORY

Steel is being used more and more for special effect in houses. To make our judges' lives and decision-making just a tad more

difficult, add to this the incredible locations of some of these entries.

So when we have entries in Rooi Els, God's Window, Sabi Sabi, Mkizi reserve, Boggomsbaai, and so on, it has to be a very special house in natural farmland north of Johannesburg to take the category award. Highveldt House is a superb example of what can be done if a big budget is available, with an architect of great repute and imagination, and who pays special attention to detail. This is an amazing juxtaposition of steel, timber, glass and concrete all set in a white stinkwood forest.

Our judges had one word to describe this house: "Wow!"

SPORTS STADIUM CATEGORY

As the name tells us we had more than just soccer entries. But in fairness, how could a small but really special indoor cricket training facility at Christian Brothers College hope to compete with say a Peter Mokaba stadium in Polokwane? But it was so interesting that the cricket facility indeed made the short list. No mean achievement considering the category it found itself in.

In this category we had the extensions to Ellis Park and Loftus, both of which are major projects in their own right, the facility at the Moruleng training ground, as well as the aforementioned Peter Mokaba stadium. Of all the projects that did not get recognised for an award surely Peter Mokaba came the closest.

So which stadium was recognised in the stadium category? Soccer City near Johannesburg, that brightly coloured calabash exterior that hides the exceptionally heavy and impressive steelwork in the girders and cantilever roof – part imported and part locally fabricated. This also applies to the design – the conceptual design was done in Germany, but the detail design was completed in South Africa.

The project involved the total refurbishment of the old FNB stadium into a 90 000-seater. The roof of Soccer City is its most important and interesting element. Constructed mainly in steel, this roof showcases the flexibility of steel through its curved shapes and radial arches, which form the central design element – the calabash.

THE MINING AND INDUSTRIAL CATEGORY

This type of work is the bread and butter of the structural steel fabricating industry

in South Africa. To win an award means that it has some special feature to it, because all the structures on display show great design, planning and execution attributes.

When you are up against all the steel work for the new Heineken brewery, or all the steel work for the Khumani iron ore project, or an extension to Columbus stainless steel, or workshop/warehouse buildings in Rustenburg, Port Elizabeth or Klipspruit mine, and if you are then 'just another headgear' you would not have won in this category.

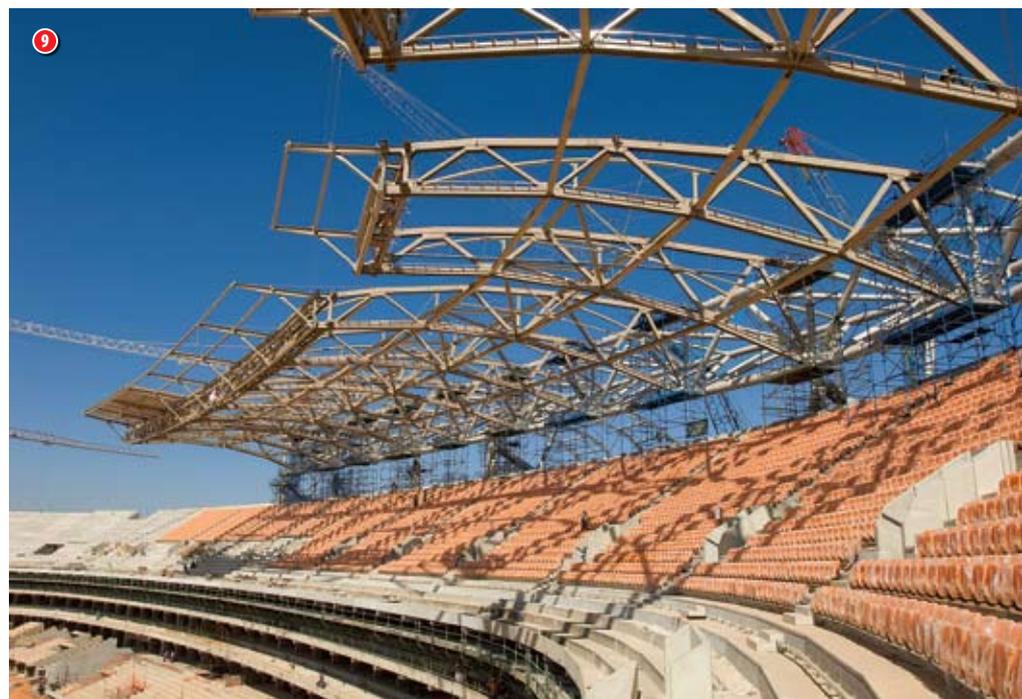
So what made the headgear of No 17 Shaft Impala Platinum special enough to be awarded the mining and industrial category award? After all, we have recognised so many headgears in the past. Why this one, another headgear?

Well, I invite you to find me any other modern headgear that displays the same quality of design and execution of workmanship as can be seen at 17 Shaft. The

7 Highveldt House situated in farmland within the Cradle of Humankind – winner of the Residential Category

8 Soccer City – winner of the Sports Stadium Category

9 The roof of Soccer City was constructed mainly in steel



site just screams at you so much about organisation, safety and planning that our team of hardnosed judges could not help but exclaim in positive terms about every aspect of this project.

Seldom in my experience have I come across workmanship of such an inordinately high standard. This should stand out as an example and shining beacon to our industry as to just what can be achieved when the mind is set to do it.

AND SO TO THE OVERALL WINNER

You have read about what a great selection of projects we had to choose from, but there was one project that just jumps out at you when you see and experience it as being the obvious winner, and that is the Moses Mabhida soccer stadium in Durban.

This project displays excellence in the use of steel in every aspect, from conception to design to completion.

Just imagine an 8 000 ton compression ring that is factory built some 600 mm too long (by design). To accommodate the extra length the tops of the steel columns lean out. Now the structure is similar in concept to the spokes on a bicycle wheel being tensioned, bringing all the load into the rim (compression ring). Just so, as the roof gets steadily built and tensioned so the load reaches the compression ring. When the full load is applied, the compression force in the ring is so enormous that the gigantic steel boxes that make up the compression ring foreshorten under load, bringing the ring back to the theoretical dimension with columns no longer leaning out.

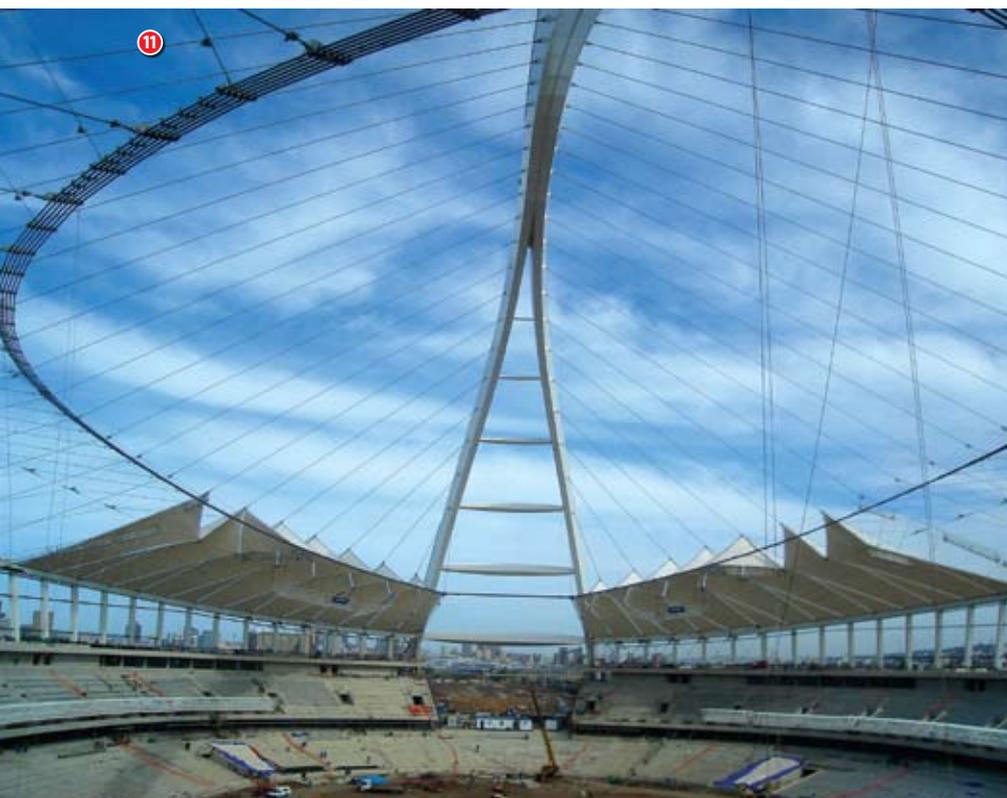
Add to this the magnificent spectacle that is the bifurcated arch spanning the full length of the field – one can be left in no doubt that this is a very special project from every aspect. A truly deserving overall winner of Steel Awards 2009!

AND IN CONCLUSION

Can there be life for steel structures now that most of the soccer stadiums have been completed and have been judged? Just watch this space – we know of some equally exciting and special projects for the next round of Steel Awards. □

10 No 17 Shaft at Impala Platinum – winner of the Mining and Industrial Category

11 Moses Mabhida stadium roof and arch under construction – overall winner of the 2009 SAISC Steel Awards





The Mgeni Viaduct launching on a 9% slope

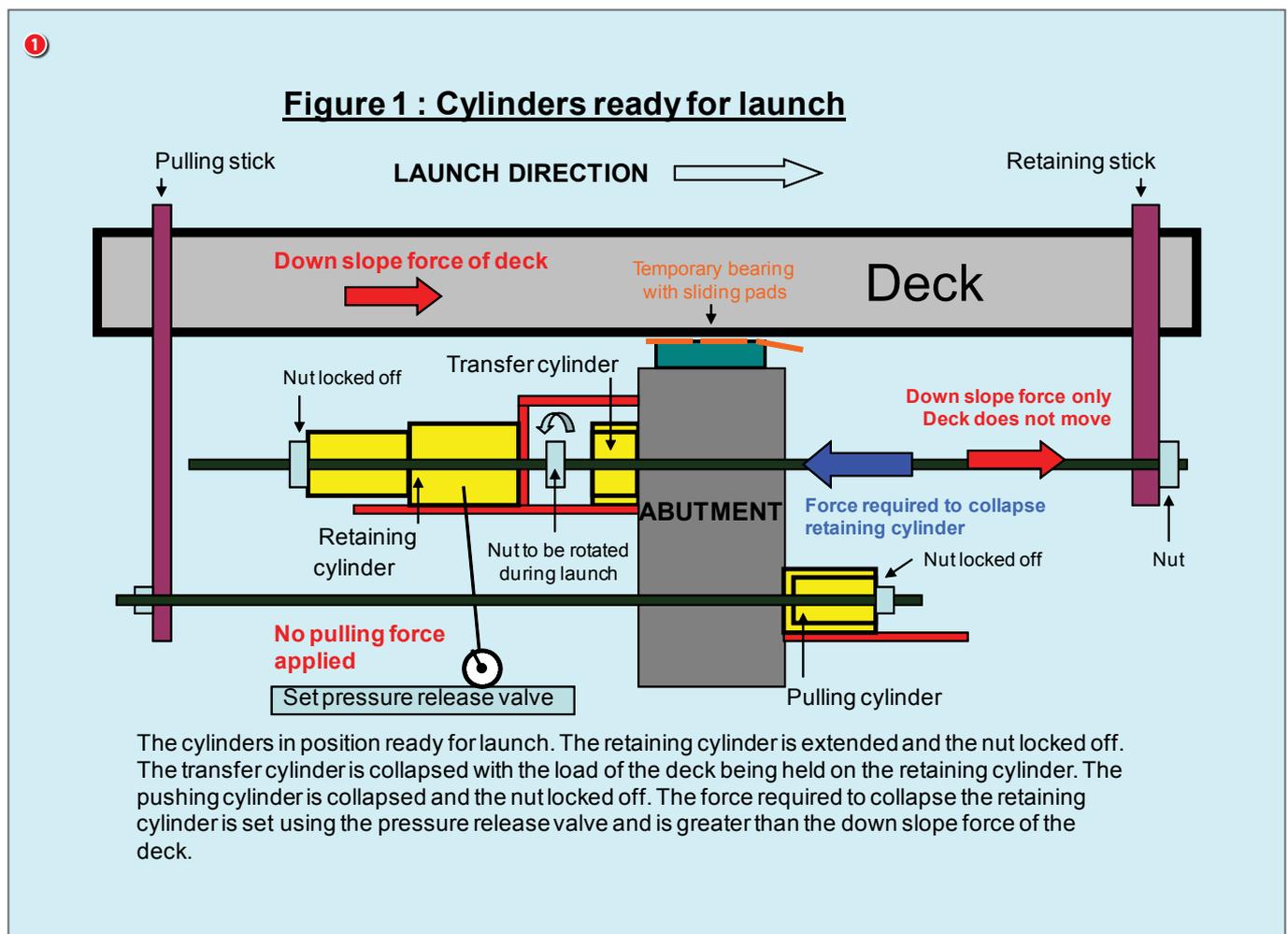
PROJECT OVERVIEW

The Mgeni Viaduct in Durban bridges the Mgeni River to link residential and industrial zones in the greater Durban area, as well as providing a link road to the new King Shaka Airport. The project started in July 2007 and is due to be completed in March 2010, with a project value of R187 million.

The Mgeni Viaduct was designed by BCP Engineers (later bought out by SSI) and constructed by Rumdel Constitution Cape Joint Venture, with the temporary works design being done by Jeffares & Green. The project was undertaken for the KwaZulu-Natal Department of Transport. The viaduct was incrementally launched at a 9% gradient from the east abutment, with the launching system being supplied by Enerpac.

The Mgeni Viaduct consists of two independent, prestressed concrete, single-cell box girders with a total length of 410 m, and has nine spans of 34 m, 36 m, 6 x 50 m and 40 m. Each deck has a width of 14,4 m and a depth of 3,7 m and is designed to carry three lanes of 3,5 m in each direction. The decks are separated by a raised median 3 m wide, and contained on either side by precast New Jersey barriers.

1 **Figure 1** Cylinders ready for launch



The deck weighs 25 tons/m and follows a constant sagged vertical curve with a radius of 3,7 km, the east abutment being 8,74 m higher than the west abutment. The piers are hollow sliding form structures founded on solid rock, varying in height from 50 to 15,5 m, with the highest four piers being stayed for the duration of the launch. The deck structure is led by a 56 ton steel nose, 30 m long, and the deck is cast in 18 segments varying in length between 11 and 25 m.

LAUNCHING SYSTEM

Launching a deck on a 9% gradient offered many challenges as the structure was unstable and inclined to move under gravity. The launching system is required to restrain the deck at 1,3 times the down-slope force of the deck, assuming zero friction. The system also needed to be able to pull the deck back in the event of a bearing misfeed with a maximum force of 10 500 kN.

This was achieved by using three 350 ton hollow plunger cylinders cou-

pled to the deck via retaining sticks installed through the box section and connected to the cylinders via 75 mm Macalloy bars. The cylinders were set up behind the left abutment, with the Macalloy bars running through the abutment. The 350 ton retaining cylinders act as the “anchor”, with the pressure-release valve being set to allow the cylinder to collapse only when a force of 1,3 times the down-slope force of the deck is applied to the cylinder. Thus the weight of the deck on its own will not collapse the cylinder so the deck does not move. These are the largest cylinders made by Enerpac to date.

In order to launch it, the deck is then pulled forward by three 150 ton pulling cylinders, coupled to the deck via pulling sticks and 50 mm Macalloy bars. When the pulling cylinders are extended, the force of the pulling cylinders plus the down-slope weight of the deck is enough to collapse the 350 ton retaining cylinders and overcome the friction, and the deck moves forward. The deck is thus moved in a safe and controlled manner, and the launch can be safely stopped at any stage by

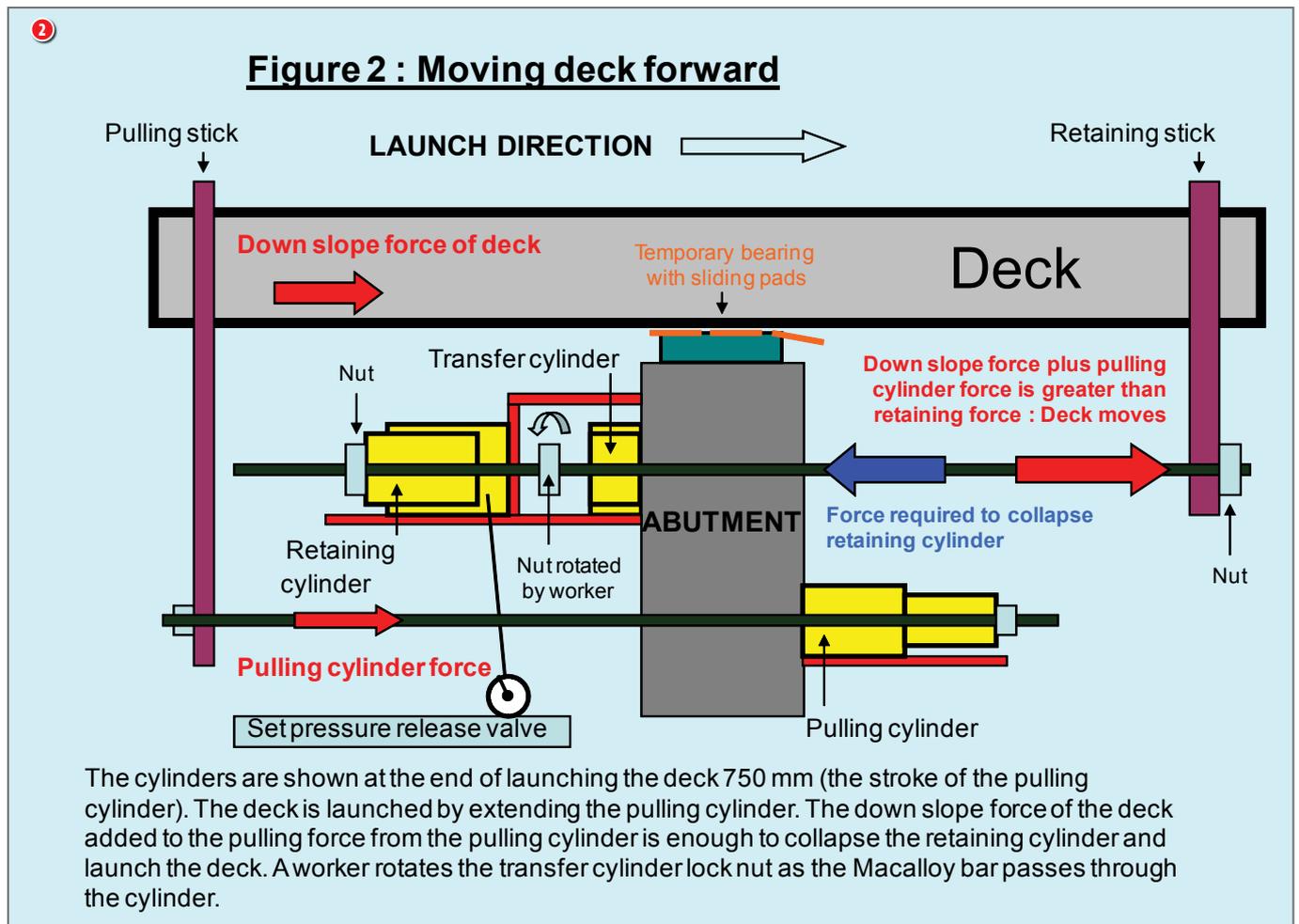
stopping the extension of the pulling cylinder. This safety feature is critical as in the event of a loss of power or pressure the deck will not move on its own because the “anchor” remains in place.

Each movement advances the deck by 750 mm before the cylinders are reset for the next sequence. The load on the retaining cylinders is transferred to the transfer cylinders at the end of each cycle, allowing the retaining cylinders to be extended. The deck is then locked off on the retaining cylinders again, the transfer cylinders are collapsed and the deck is launched again. The launch sequence is illustrated in Figures 1 to 4.

The launching system is controlled from a central computerised control panel where pressure parameters for the retaining and pulling cylinders can be set. This allows the launch controller to set the system to shut down if the anticipated launch force required for launching of that segment is exceeded. This may occur if a bearing is fed in upside down or something is obstructing the deck.

The system may be operated in manual or automatic mode, with the automatic cycle making use of

2 Figure 2 Moving the deck forward



electronic sensors in the hydraulic cylinders to indicate to the control panel when each movement in the launch cycle is complete. The release pressure for the retaining cylinder is set with a manual pressure-release valve and the cylinder pressures can be read off dial gauges on the valve block or off the control panel.

The launching system also includes emergency switches on all the piers which are linked into clinometers installed on the four highest piers. The clinometers are equipped with electronic sensors which automatically shut the system down if the pier deflects beyond the stipulated tolerance.

include the original design steel for easier and faster construction. As the deck grew longer and the launch loads increased, the steel was increased to cater for the increasing loads. These holes were then filled in after the segment had been launched.

The pulling/retaining cylinders kick against the left abutment and sleeves were left in the abutment to allow the Macalloy bars to pass through. During the construction of the left abutment foundation it was found that a fault line ran through the centre of the abutment. The possible slip was overcome by installing additional ground anchors at different angles 16 m into the rock face. Additional sleeves were left in the abutment in case any of the ground anchors failed. Fortunately, none of the additional sleeves was required.

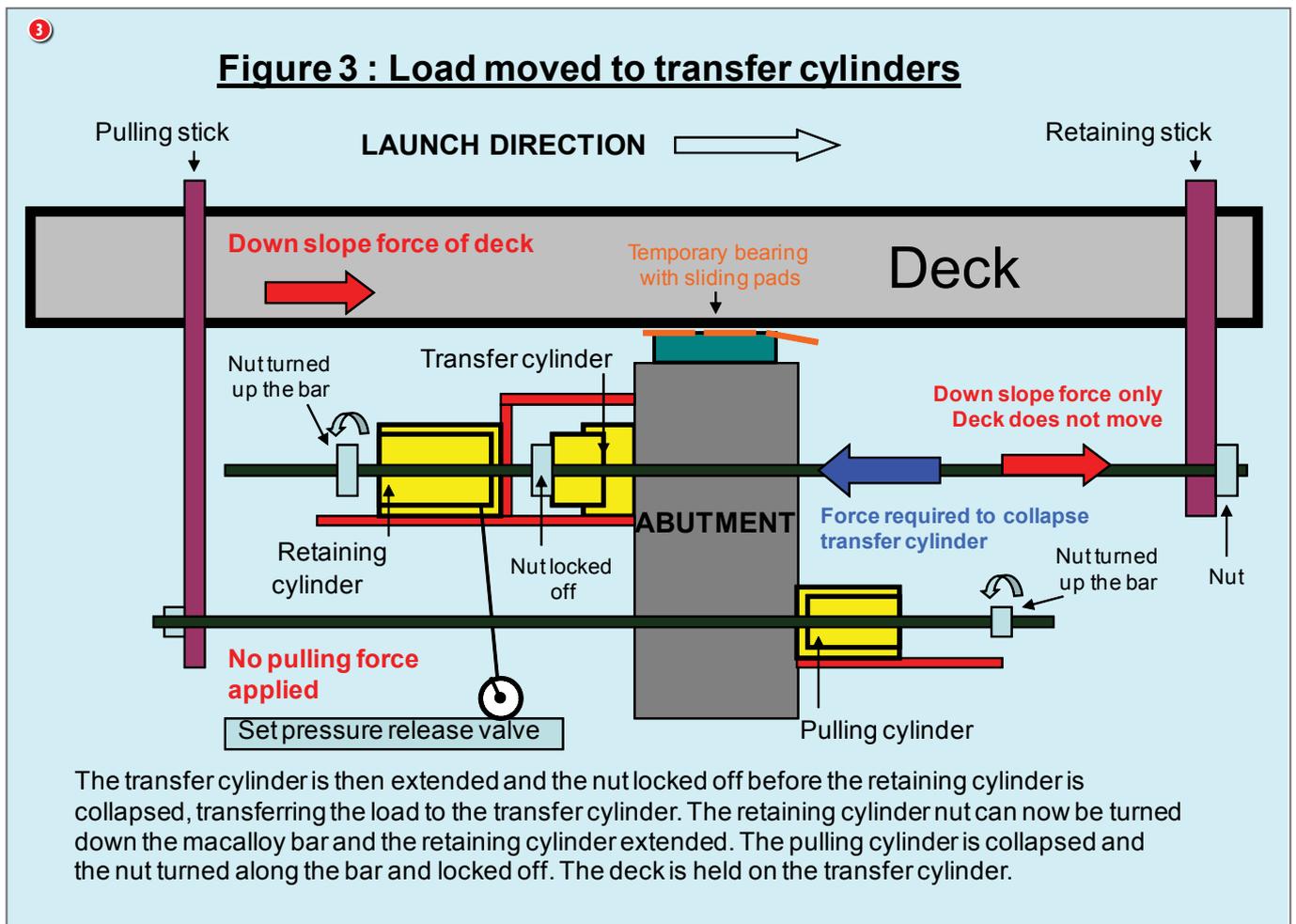
MODIFICATIONS TO FACILITATE THE LAUNCH

Due to the high launch loads imposed on the box section through the pull sticks, it was necessary to modify the deck and soffit. The area around the pulling and retaining stick holes was thickened and additional steel reinforcing was installed to cater for the launch loads. The thickening gave the pulling/retaining sticks a larger bearing area on the soffit. The steel arrangement was then redetailed to

CONSTRUCTION

The casting area is situated in a cutting and the rest of the establishment for the construction of the deck on the adjacent fill, which made for a very congested site. The limited storage area made the scheduling of stock delivery and control critical as not much could be stored on site.

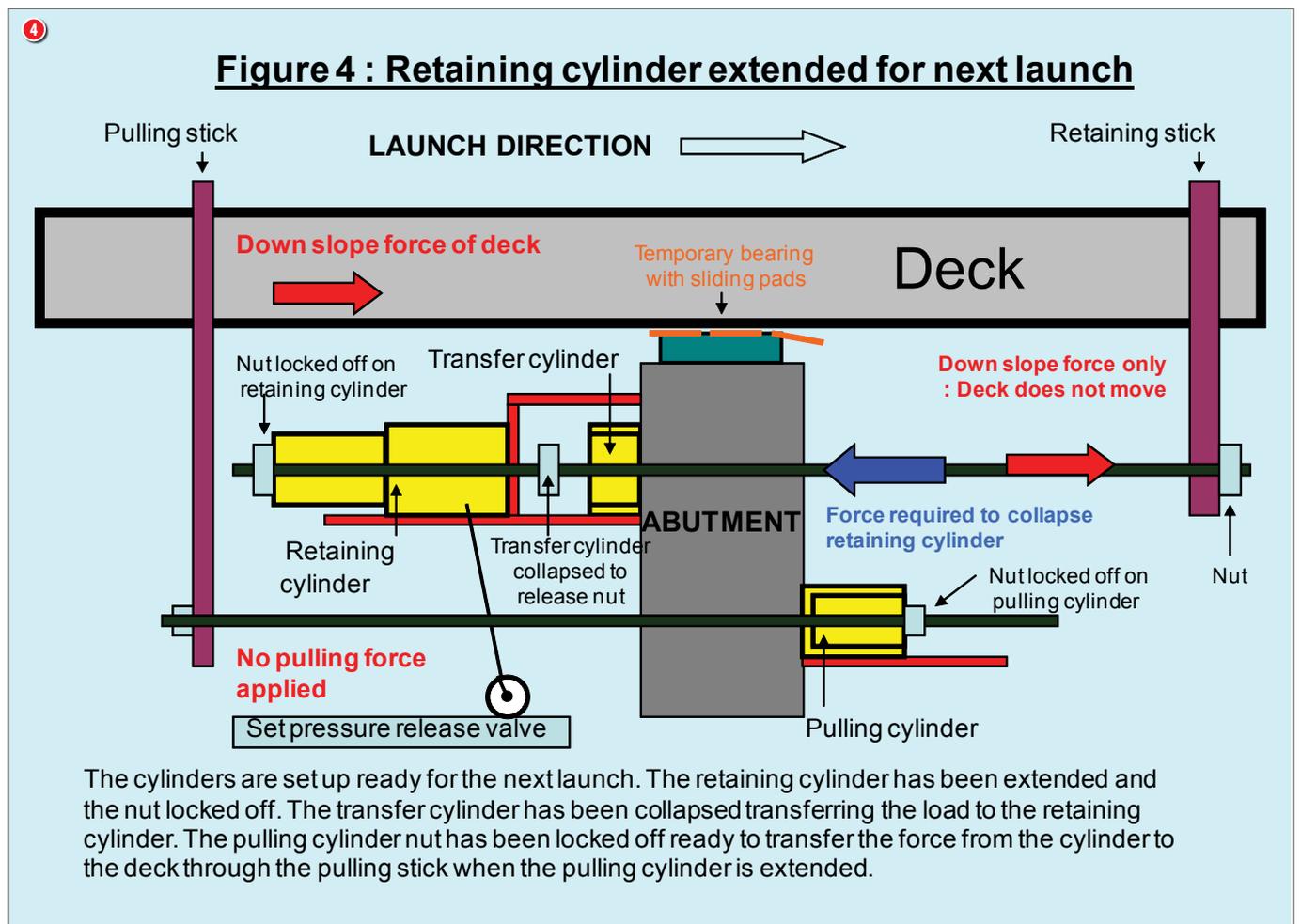
- 3 **Figure 3** Load moved to transfer cylinders
- 4 **Figure 4** Retaining cylinder extended for next launch
- 5 Launch system power pack and control panel
- 6 Extended retaining cylinders
- 7 Extended pulling cylinders
- 8 Transfer cylinder locked off with split washer and nut
- 9 Retaining stick with Macalloy bar coupling it to the retaining cylinder



The decks were launched simultaneously with segments being constructed in a cycle time of 12 to 14 days. The concrete is batched on site using a Karoo batcher and is placed using 2 m³ buckets. The box sections are cast in three sections, first placing the soffit, then the webs and finally the deck. Due to the high cement content and summer temperatures in Durban in excess of 32°C, the concrete is required to be placed below 30°C. This is achieved by cooling the water to 1°C and keeping the aggregates under insulated roofing. The 19 mm stone is kept wet using sprinklers to reduce its temperature and ice is on hand in a freezer container if required.

A strength of 35 MPa was achieved in 36 hours before the concentric prestressing was done. Cubes are match cured on the deck under insulated boxes to get an indication of the actual strength of the element, while an on-site lab cures cubes in curing tanks for quality control purposes.

The steel is prefixed outside the shutter form and rolled into place once the previous segment has been launched. The casting bay was constructed on the



radius of the vertical curve with a dip of 25 mm over the 25 m segment. The skid beam was set up to within a 1 mm tolerance and the formwork raised and lowered on 100 ton jacks. No settlement was experienced as the casting bay foundations were constructed on the bedrock in the cutting.

COMPLETION

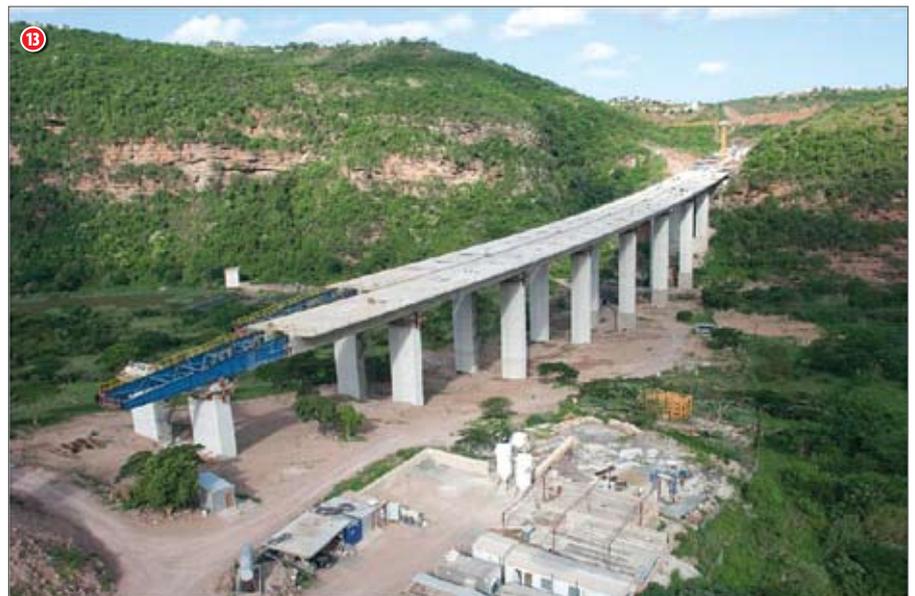
We are currently busy with the final segment and the viaduct is due to be completed in March 2010. The deck will be pulled into its final position from the right abutment. The pulling cylinders will shortly be relocated to the right abutment and holes have been left in the second segment so that the pulling sticks can be installed.

The diaphragm walls will then be cast over the piers and the drape cables stressed before the New Jersey barriers

are installed. These barriers have been precast at the precast yard at the right abutment and are ready for installation. Piers 3, 4 and 5 have fixed bearings and the retaining sticks and cylinders on the left abutment will remain in place until these have been installed. The temporary bearings will be replaced with the permanent bearings by jacking the deck using 4 x 500 ton pancake jacks supplied by Enerpac. The temporary bearings will then be broken out and lowered to the valley floor. The permanent bearings are already located on the piers and will be moved into place and grouted. This process was due to start early in 2010.

Although the project offered many challenges, these have been overcome by the close working relationship between the various design consultants and the contractor. We look forward to opening the bridge to traffic. □

- 10 Soffit and web steel, with steel thickened around pulling stick holes boxed out
- 11 Pier stays to stabilise the piers during launching and deflect the piers forward so that they will move back when the deck moves over them. This was required due to the 9% launch slope
- 12 Construction of the casting bay and pier heads. Note the congested construction area for the casting bays
- 13 Deck nearing the right abutment
- 14 Mgeni Viaduct in Durban nearing completion





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1



Telkom Soccer Balls – Lukasrand and Hillbrow



IN 2008 THE AGENCY came up with the idea of constructing large soccer balls on some of the Telkom towers as an advertisement for Telkom. These balls were to be the largest ever used to advertise a soccer world cup event. The Agency then approached Graphic Wizard with the idea, who in turn contacted Signsmith cc regarding the project. Signsmith thought out the concept design of how to make and install the balls and they then approached a commercial artist to put the original concept into a form that could be used in a presentation. Extremely large banners, with the Telkom corporate colours, were shown hanging below the balls. Three potential towers were identified for placing of the soccer balls so that they would be visible from the bigger soccer

- 1 The Lukasrand Tower, Pretoria, with the completed soccer ball, at the opening ceremony
- 2 This picture shows the two rectangular columns cutting through the ball, thereby effectively cutting the two inner circles
- 3 This picture shows the bottom ring and how the rest of the assembly had to be done by access ropes. The ring was so positioned that the compression and the tension occurred on the corners of the hexagonal central column



stadiums. During breaks in the soccer matches, TV cameras could focus on the balls. The three towers that were identified were Lukasrand in Tshwane/Pretoria, the Hillbrow Tower in Johannesburg and the Telkom Tower in Durban. This concept was then sold to Telkom management and they gave Signsmith the go-ahead for the project.

Once approval of the budget had been obtained, Signsmith contacted structural engineer Fanie Joubert regarding engineering details for the manufacturing of the balls, and at this stage I also joined the team. The balls were planned to have a steel frame, consisting of rings at the top, middle and bottom that would be fixed to the central column in some way. The outer skin of the balls would be manufactured from glass fibre reinforced plastic in 48 segments, spanning between the top or bottom and the middle rings.

Fanie Joubert and I then took over the design of the balls. Initially it had been planned to stick with the original idea of panels spanning between the central ring and the two outer rings. However, once one of these panels had been constructed, they proved to be too flexible and it was then decided to construct the ball with

five rings and to increase the number of panels to 96. These were then easier to lift and place. The total mass of the fibreglass panels was in excess of 27 tons.

LUKASRAND

The Lukasrand Tower in Pretoria has a base that consists of a central hexagonal column and three rectangular columns at 120°, placed so that the inner smaller face is parallel to the face of the hexagonal column. At the top of the four columns are intermediate office floors and above that one of the columns is discontinued. Here there is a gap of about 24 m, into which the ball would be placed. Above that is the telecommunications section.

As the ball at Lucasrand would be placed between floors, it was necessary to erect the pre-made sections of the steel frame in the ball's final position. The ball was to be fixed to the central hexagonal column and would have the two outer rectangular columns running through it. The frame had to then pass on either side of the rectangular columns and the central ring was divided into 12 equal portions.

All the major elements of the steel structure were planned using round hollow sections, as the elements were long and

subject to buckling. The rings were also of round hollow sections, as they had to be curved and had to carry torsion moments. All connections were planned as bolted connections. The construction sequence was such that the top and bottom rings were placed first, and these were used as the platform for the further erection of the support structure. At that time it made sense, as the rectangular columns did not interfere with these rings. Once the rings were in the correct position, they were fixed to the central column with chemical anchors. The top-down frames were placed next and these were then connected to the top and bottom frames/rings. Already at this stage, the erection was being undertaken by Rope Access Technologies and all the fixing and welding had to be done up in the air. The second rings from the top and bottom were placed next as these were non-continuous, being cut by the rectangular columns. These were then fixed to the columns so as to give the structure some stability.

Finally the central ring could be fitted. This did not happen as smoothly as had been hoped as the whole ball was very sensitive to dimensional errors. Cross checking of the dimensions up in the air

proved to be extremely time-consuming and difficult. To overcome the dimensional problems and eliminate the errors that appeared to have been made, the coordinates of all the nodes were calculated and their position in space fixed. A Total Station, set up over a fixed point, was then used to guide the rope access team so that they could do the necessary adjustments. Eventually the dimensional problems were overcome and the frame could then be clad in the GRP panels. These had to be hoisted past the bottom floor and swung until they were in position. They were then bolted onto the frames.

Once the ball had been completed the banners were fixed between the three rectangular columns and this was shown to the people of Tshwane in the opening ceremony. At the opening ceremony Telkom was presented with a plaque by the Guinness Book of Records, as this ball is the largest ball to be erected in honour of a soccer world cup and it now officially holds the 2009/2010 Guinness Book of Records title with a diameter of about 24 m (7 storeys).

Tower ball was set in motion. Lessons that had been learned during the construction phase of the Lukasrand Tower ball were fruitfully applied to the construction of the Hillbrow Tower ball. The column in this case is round and the sides are vertical. It was decided to construct the ball in sections on a platform a little way up the tower and, once completed, to hoist the ball up the tower and then to fix it in position. The first ring was built on the platform and lifted so that the next ring could be fitted. This sequence of completing and lifting was used until the whole ball was finished. This made the manufacturing and erection of the ball substantially less challenging.

It was only in the hoisting phase of the ball, that the erection had to be stopped and the necessary wheels placed around the inside of the bottom ring to prevent the ball from getting damaged against the column due to unexpected high winds and electric storms that Gauteng experienced during the construction phase of both balls.

This ball has the same diameter as the Lukasrand Tower ball, i.e. about 24 m, and should share the Guinness Book of Records honour. □

Subsequent to the completion of the Lukasrand Tower ball, the Hillbrow Tower ball was set in motion. Lessons that had been learned during the construction phase of the Lukasrand Tower ball were fruitfully applied to the construction of the Hillbrow Tower ball

- 4 The completed Lukasrand Tower ball
- 5 Hillbrow Tower, Johannesburg, with its completed ball

HILLBROW TOWER

Subsequent to the completion of the Lukasrand Tower ball, the Hillbrow





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2010 FIFA WORLD CUP

THE 2010 FIFA WORLD CUP SOUTH AFRICA™

An overview of this exciting event



GENERAL

The FIFA World Cup is the largest sporting event ever to reach the shores of South Africa. It may well be the biggest event ever to be staged in this country. The World Cup accommodates 32 teams in four sections representing the various regions of the world, i.e. Africa, Europe, South America, Oceania and North America. The teams are divided into four groups for the first round. The draw was recently made and South Africa was drawn to play Mexico at Soccer City in the opening match on 11 June 2009.

There are ten match venues in nine cities (see Table 1). The figures include the seats for the media, VIPs and the broadcasters.

The original bid document nominated 13 stadiums. Soccer City was nominated as the preferred venue for the final and opening matches, while Ellis Park and Durban were to stage the semi-finals. FIFA would have accepted eight venues as the minimum for the eight groups of four teams, satisfying the requirements for the opening round.

The Organising Committee, after consultation with the South African government, decided to propose ten stadiums.

Table 1 Match venues

Venue	City	Capacity	Important match
Soccer City	Johannesburg	94 000	Opening & Final
Green Point	Cape Town	70 000	Semi-final
Moses Mabhida	Durban	70 000	Semi-final
Nelson Mandela	Port Elizabeth	48 000	Quarter-final
Ellis Park	Johannesburg	50 000	Quarter-final
Free State	Mangaung/ Bloemfontein	48 000	Round 16
Loftus Versfeld	Tshwane/ Pretoria	50 000	Round 16
Royal Bafokeng	Rustenburg	48 000	Round 16
Peter Mokaba	Polokwane	48 000	Group Round
Mbombela	Nelspruit	48 000	Group Round

New stadiums were constructed in Durban, Cape Town, Polokwane, Nelspruit and Port Elizabeth, and Soccer City was substantially upgraded. It was also decided to award the semi-finals to Cape Town and Durban, with the requirement that they must be able to accommodate a minimum of 60 000 spectators and an additional ca 9 000 seats to accommodate the VIPs and the media. It was not possible to increase the capacity of Newlands Rugby Stadium or Athlone Stadium in Cape Town, or ABSA Stadium in Durban to the required level of accommodation, and new stadiums had to be offered. The result was a proposal for a new stadium in Green Point.

Durban decided to build a new stadium to address long-term goals for the city, and the Moses Mabhida Stadium was designed for this purpose. Both stadiums had to offer the 69 000 seats required for the World Cup, while 55 000 would be the preferred number for the legacy stadium. The stadiums will provide addi-

tional temporary seats for the World Cup to increase the capacity to the required minimum.

HOW IMPORTANT IS THE FIFA WORLD CUP?

The most striking way to assess the importance of the Football World Cup would be to use the collective worldwide television audience. This means taking the total number of spectators tuning into the TV feed for all the matches and adding the totals.

The comparison in Table 2 illustrates the massive opportunity the World Cup presents to promote South Africa as a desired destination for both tourism and investors.

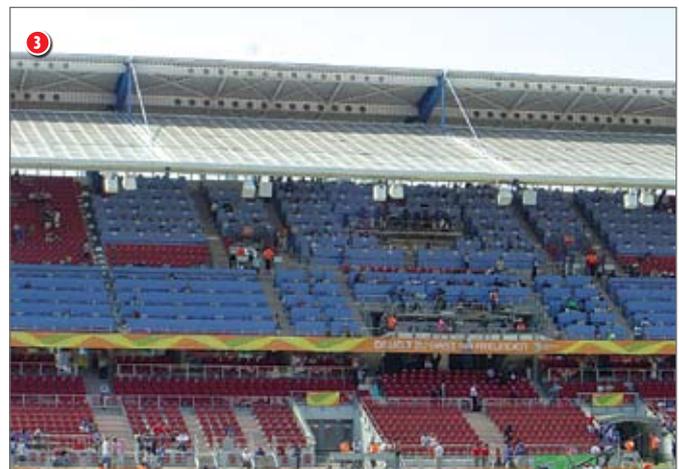
THE FAN PARKS

The so-called Fan Parks will be as popular in South Africa as they were in Germany for the 2006 World Cup. The demand for match tickets is expected to far exceed the number available. The Fan Parks are public viewing areas set up to address the demand for live coverage in a football environment. The writer had the pleasure of watching a match in Berlin during the 2006 World Cup. On that day the audience at the Fan Park was estimated at nearly one million! What a sight and atmosphere! Various Fan Park sites at which giant TV screens will be installed are planned in a number of cities.

- 1 Croatian supporters enjoying every moment at the 2006 event in Germany
- 2 For some fans the 2006 event was a first experience
- 3 The media have to be accommodated adequately for an event of this magnitude
- 4 Hospitality village at the 2006 event in Germany

Table 2 Comparison of World Cup television audiences

Event	Collective television audience
FIFA Football World Cup	25–30 billion
IRB Rugby World Cup	1,5–2,0 billion
ICC Cricket World Cup	1,5–2,0 billion



WORLD CUP SPECIFIC DETAILS

The various elements of the World Cup illustrate the nature of the event and the logistics needed to make it happen.

Television broadcast and media

Recent Rugby or Cricket World Cup events in South Africa required about ten commentary positions and 100 press desks, with a limited number of observer seats for the media. The final of the FIFA World Cup demands 1 000 desk positions and 260 commentary positions. In addition, 1 000 observers and 100 photographers are to be accommodated in the main stands. The result is that a stadium such as Ellis Park would have no seats available for the public on the upper tier of the Western Stand: it would be wholly occupied by the media!

The Media Centre will be a temporary structure on a site of 5 000 m², about the size of half a football field. The site will be equipped with all that the media need to be in constant contact with their bases wherever they are in the world, sending the news and photos in real time. The broadcast compound where the satellite farm and the broadcast trucks are to be accommodated will occupy another 5 000 m², with at least 10 to 20 broadcast trucks, depending on the importance and popularity of the match.

Hospitality

The requirements of hospitality demand massive space to accommodate temporary structures. World Cup hospitality is divided into three categories:

- Important guests such as VIPs and VVIPs (Heads of State)

5 As in Germany in 2006 "ambush marketing" will not be allowed during the 2010 event

6 Hugely popular in Germany in 2006, Fan Parks are public viewing areas set up to address the demand for live coverage



- FIFA sponsor hospitality – the sponsors pay enormous amounts to be part of the event
- Commercial hospitality such as package deals, including tickets, accommodation and transportation

The numbers are so large that normally it is not possible to satisfy the demand with existing buildings, and therefore temporary structures are utilised. The size of the areas required is mind-boggling: the final would demand 50 000 m² for both commercial and sponsor hospitality, with a total area of 75 000 to 10 0000 m² or 10 to 12 football fields. These facilities are all air-conditioned and have high-level finishes.

The IT backbone demanded for the event is one of the many benefits that may remain after the World Cup. Communication to the world is regarded as of principal importance and the legacy could be that the IT remains for future use after the event.

Floodlights

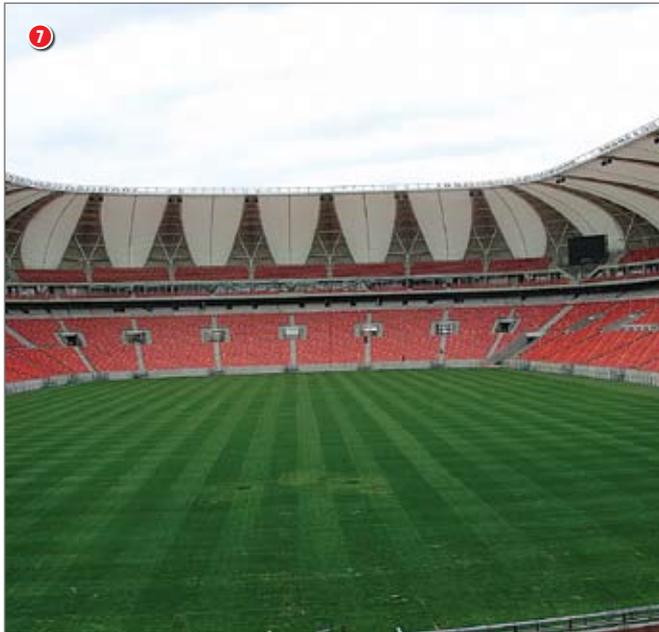
The standard of stadia floodlight illumination is aimed at high-definition television as offered by the host broadcaster. The illumination levels in the existing stadiums such as Ellis Park and Loftus were about 1 000 lux, whereas the demand for the World Cup is at least 2 000 lux.

Access control

The need to guarantee, for both security and other reasons, that only spectators with valid tickets enter the stadium made

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- 7 The Nelson Mandela Stadium in Port Elizabeth
- 8 The Moses Mabhida Stadium in Durban
- 9 Prof Eugene van Vuuren (right) at the Allianz Stadium in Munich with Frik van der Merwe, project manager for Polokwane Stadium



it a requirement for the stadium authorities to install turnstiles equipped with scanners enabled to read tickets with embedded security measures. The information will be stored so that at any time Disaster Management will be able to verify the number of people passing through any gate and the total number of spectators in the stadium. It will also discourage counterfeit tickets and the illegal use of tickets.

Accreditation centres will be established at all the stadiums to allow only accredited people to enter the various accreditation zones inside and outside the venues.

Volunteers

An important component of any World Cup or major sporting event is the volunteers. Without the volunteers the event would not be possible. The volunteers are to be accommodated in volunteer centres serving as resting and logistic areas.

Marketing

“Ambush marketing” has to be denied as the event is dependent on the generosity of its sponsors. It would therefore not be in the interests of any party to allow the abuse of the event for the promotion of non-sponsors. Exclusion zones around the stadiums are established by FIFA, the host cities and the Organising Committee; these are zones in which any commercial activity is prohibited unless sanctioned for the event. This action is necessary to protect the interests of the sponsors who invest millions of dollars for exclusive marketing rights.



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SSI's engineering expertise continues to provide infrastructure solutions for our developing nation be it roads, safe drinking water, sanitation, housing - all of which contribute to improving the quality of life.



As a good corporate citizen, our Saturday School Initiative is just one way we approach sustainability, ensuring that through our Corporate Project Responsibility policy, we leave the planet in better shape than we found it.

SSI Engineers & Environmental Consultants, protecting our world beyond 2010.

Ambience

The FIFA World Cup is a fantastic event. South Africa has never staged, and probably will never again stage, an event of similar size – not even the Olympics. The fact of having visitors (both supporters and teams) from 32 countries simultaneously will be something to experience. We as South Africans have to embrace not only the event but also the visitors, many of whom will be here for the first time.

ABOUT THE AUTHOR

Prof Eugene van Vuuren is a member of the Technical Team of the Local Organising Committee of the 2010 FIFA World Cup. He was also co-author of the technical bid for the FIFA World Cup 2010. Prof van Vuuren is a consultant on stadiums to the following:

- International Cricket Council for the Cricket World Cup
 - 2003 South Africa
 - 2007 West Indies
 - 2011 India, Sri Lanka and Bangladesh
- England Bid for the 2018/2022 Football World Cup
- South Africa Bid for the 2015 Rugby World Cup ■





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OTHER PROJECTS

Water hammer and transient analysis – an agricultural perspective

REPEATEDLY AT MBB CONSULTING ENGINEERS we see the expensive and often chaotic results of farmers and developers not obtaining specialised engineering input when installing large-scale irrigation or bulk water supply systems. In fact, any system that presents challenges or is outside normal parameters requires engineering expertise to ensure that problems are dealt with ef-

fectively and that the system meets delivery requirements. The following case study illustrates this point.

Early in 2009 we were contacted about a sizeable bulk water supply system which was to extract water from the Zambezi River to irrigate over 1 000 ha of grain and fodder crops on a farm in the Chiawa region of Zambia.

The irrigation contractor had advised the farmer on the type, size and costs for a bulk water supply component of agriculture, but had not carried out a detailed engineering

① Laying pipelines on a farm in Zambia for a bulk water supply system to irrigate over a 1 000 ha of crops



design. The proposal was based on a very brief hydraulic analysis and the choice of pipe sizes was made based on the ease with which pipes could be nested for transport; this included three sections of glass-reinforced plastic (GRP) pipes, 2 050 m in length, respectively 1 100, 1 200 and 1 300 mm in diameter. The potential effects of water hammer were thought to have been covered by a conservative selection of one class of piping of higher pressure than the basic design required.

Initially, the installation of the system was to be undertaken on an in-house basis. However, on further reflection it was realised that the considerable risks posed by such large-bore pipe installation was beyond the contractor's experience. It was therefore decided to obtain the services of a specialist engineer to investigate the hydraulic and structural aspects of the planned installation.

MBB Consulting Engineers were requested to look at the system as supplied, and decide whether any remediation measures were necessary. In addition, it was accepted that the installation process required engineering supervision to ensure that the pipeline would be installed to the manufacturer's specifications.

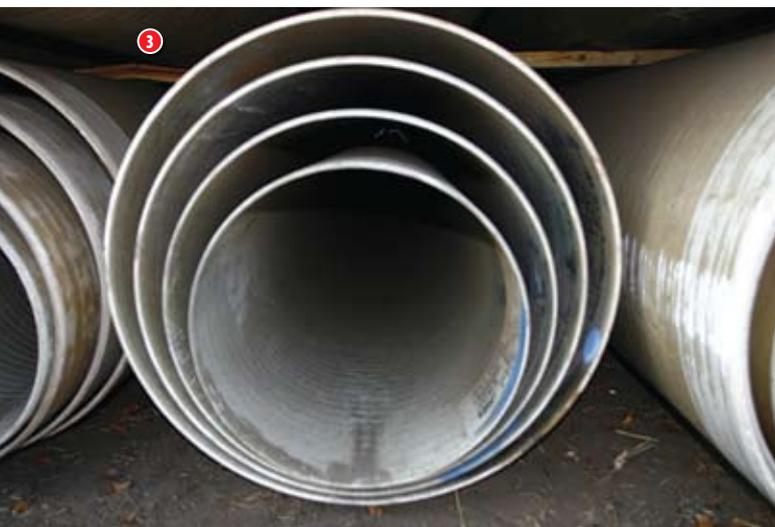
A detailed survey was commissioned within the pipe servitude already allocated. This route allowed for marginal changes, essentially reducing the number of vertical and horizontal bends. Specifications for the planned pipeline were supplied by the manufacturer and a hydraulic transient analysis was carried out using Hytran – a software package analytical tool developed by Dr Norman Lawgun, School of Engineering, University of Auckland, NZ, to analyse hydraulic transients (water hammer) in pipe networks.

This software allows the real-time analysis of hydraulic transients after the system has been defined as a composite of pipe sections and boundary conditions. These boundary conditions define items such as inlets, outlets, pumps, valves and air valves that have a causative effect on pressure wave characteristics within the pipeline.

The analysis immediately identified numerous problems. Initially, even though the pipeline itself had been cautiously selected to cope with overpressure, little thought had been given to the potential effects of partial vacuum pressures. Common power failures in the region will cause regular pump trips, each resulting in sections of the pipeline experiencing either full vacuum or rapid overpressure conditions.

These two effects would cause material fatigue, leaking seals and long-term deterioration of the pipeline if there are no significant mitigation measures. In addition, using rules of thumb for installation of the pipeline, and subsequent concrete thrust blocks at bends and terminal points, would have led to early failure. Owing to the massive momentum of water in pipes of such large diameter, the resolution of thrust from the pipeline to its surrounding medium necessitated structural design of the thrust blocks. The standard practice of constructing mass concrete blocks would not have been sufficient.

Perhaps the most dramatic effect of ignoring engineering design is the potential this particular system had of completely destroying the pump station. The degree of reverse thrust developed after a pump trip would almost certainly have ruptured the bearing wall of the concrete river pump station where the pipe manifold started. Mitigation of this issue required the construction of a 150 m³ concrete thrust block, in addition to strengthening of the internal pump station walls with buttresses, and



excavation and backfilling around the rear of the pump stations with cement-stabilised backfill.

Mitigation measures along the pipeline included the construction of five discharge tanks and the installation of five air-valve chambers. In addition, a horizontal air chamber was built to be installed at the pump station, comprising two steel pipes 800 mm in diameter. These operate by the air in the chambers being compressed by the normal operating pressure acting at the node. When the pressure in the pipe falls below the air pressure, water is forced into the pipeline. As the air volume expands, the air pressure in the chamber falls. When the pressure in the pipeline is greater than the air pressure in the chamber, water is forced back into the chamber until the pressures are equalised. This system therefore effectively acts as a “shock absorber”.

② Large bulk water supply systems need specially designed thrust blocks at bends and terminal points of the pipeline

③ Large bore GRP pipes nested for transport; this method tends to prevent damage during transport

After the introduction of air valves, discharge tanks and an air chamber at the start, the resulting scenario is far better – with a minimal increase in maximum pressures from the operating pressures, and negative pressures well within the constraints of the system.

This type of analysis highlights the dangers that may be present in the design of systems that are out of the ordinary. The advent of easy-to-use irrigation and pipeline design software has possibly made the designer less aware of the hidden dangers that may be present in a system. Steady-state hydraulic assessments and simple approximations of water hammer effects cannot adequately address the complexities that often arise in large or complicated pipeline networks. Only a thorough knowledge of the inter-relationships between conduit materials, pumped mediums and boundary conditions, together with appropriate software, can fully prepare the designer for extraordinary pipeline designs and long-term successful operations.

Installation of the system started on 8 September 2009. MBB project-managed and supervised the installation, which was completed on 10 December 2009. The installation process was beset by the usual problems facing projects in Central Africa, including delays in delivery of materials, sourcing suitable construction equipment, bridging local skills gaps and training workers in appropriate construction methods. Final testing and handing over of the system is expected to take place during March 2010. □



GENERAL INTEREST

Road safety auditing

SOUTH AFRICA IS FACING a problem with road safety. With over 1 000 deaths on the roads in December last year alone, the challenges to combat the problem seem quite large. To put it into perspective, more pedestrians were killed in the traffic in South Africa in December than were killed in the traffic in Denmark in an entire year!

There are a number of different factors contributing to traffic accidents and therefore strong cooperation between the main stakeholders is necessary to solve these problems. One of the factors, however, is the physical infrastructure – an area in which Europe has led the way in reducing road accidents. In more and more European countries road safety audits have become a mandatory exercise that has to be carried out every time major roadworks are undertaken, whether

these involve new construction or rehabilitation work. This type of preventative engineering operation has proved that it is far cheaper to prevent than to cure. Up to 30% fewer fatalities have been recorded when a road safety audit has been carried out, compared with similar roads where it has not been done.

An example (again from Denmark) is that on freeways the ratio of fatalities originating from road accidents is 10 times less than on normal roads. Does that mean that when the driver leaves the freeway to continue his journey on a normal road he suddenly becomes completely careless or does the physical environment help to prevent accidents? The latter is believed to be the case and therefore the government of Denmark has made it mandatory to focus on road safety engineering with strong emphasis on preventative engineering meas-

ures. The results have been very convincing and Denmark now has a road accident fatality rate of around 300 deaths a year. Compare this with a rate of 900 to 1 200 fatalities for South Africa in just one month!

Roadworks are normally regarded as just one of a number of contributing factors that eventually cause an accident. When I look at the situation in South Africa (where I have now been living for over a year), it appears that excessive speed, alcohol abuse, fatigue among truck drivers and minibus-taxis in terrible road-worthy condition are all areas that create the foundation for the not-so-impressive accident statistics. But the area where South African authorities can make an enormous difference is preventative engineering measures. In Europe road safety audits have proved to be very fruitful in combating road accidents.

So what exactly is a road safety audit and does road safety engineering indeed have such a major impact? In simple terms, a road safety audit is a systematic method of checking the safety aspects of new roads in order to detect potential safety hazards so that they can be designed out before the road is opened to traffic. The principle behind it is that “prevention is better than cure”. Road user error is normally seen as the major cause of road accidents, but defects in the road environment (poor alignment, inadequate signing, dangerous obstacles, etc) are a major contributory factor in many cases. Remedying these defects at the design stage is an economical and effective way of reducing road accidents and preventing injury.

The main aim of a safety audit is to ensure that all new road schemes operate as safely as is practicable. This means that safety should be considered at every step during the preparation and construction of any road project.

The principles of a safety audit have been established through experience of effective accident remedial programmes, and through planned studies of the influence of design and traffic management on safety, and of the factors contributing to the occurrence of accidents.

The outcome of the audit is the identification of any potential problems, together with recommendations on how to rectify these problems.

For this practice to be successful in South Africa, the following principles need to be kept in mind:

- A safety audit needs to be an integral part of road planning, design, construction and maintenance.
- The audit should be carried out by people with road safety engineering experience, working independently of the design team – hence the term “audit” as compared with a quality control process.
- The audit report should refer only to matters relating to road safety.
- Experience with the practice should be fed back, monitored and the procedures adapted in the light of that experience.

After a reasonable period, say two years, the revised version of this practice should be incorporated into road legislation.

ORGANISATION

Safety audits involve three parties with defined roles, namely the client, the designer, and the auditor.

The client is the organisation that commissions the design, pays for it and owns the road project. The client is responsible for having an audit carried out. In the case where the designer and auditor disagree, the client will decide the issue and advise (in writing) the two parties.

The designer is the party responsible for the project planning/design. The designer reviews the auditor’s comments and ensures that the client is advised of any disagreements with regard to the design or audit.

The auditor is an *independent* consulting engineering company or person who critically reviews all project materials in terms of best road safety practice and identifies and describes all project-related road safety concerns from the perspective of all road users. The auditor does not participate in the planning or design of the project, nor does he or she rate economic considerations higher than safety considerations.

Auditors need to be specialists empowered by established procedures. In

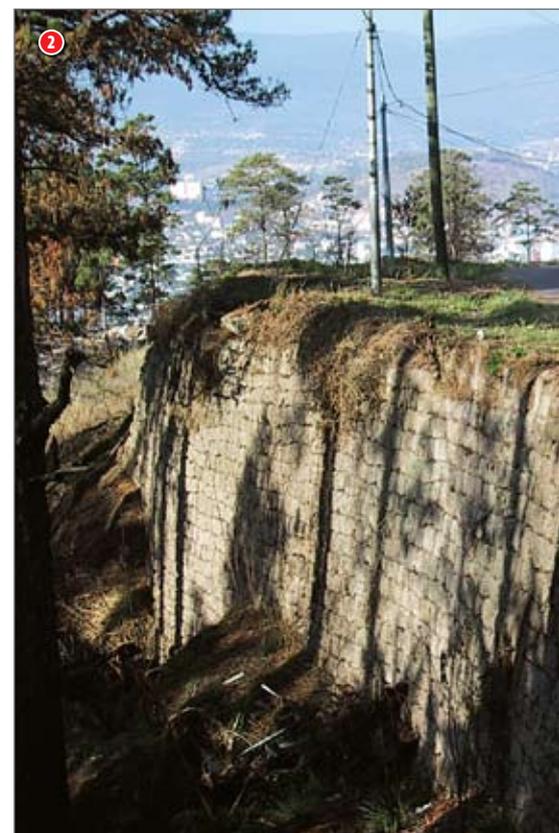
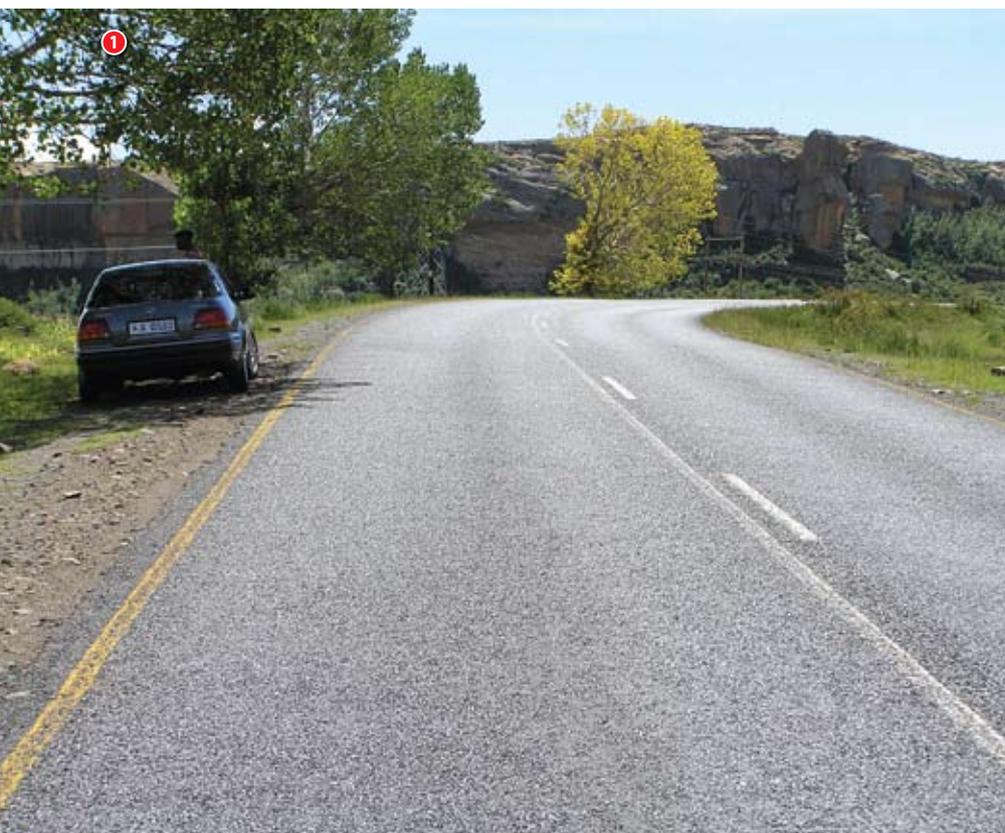
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1 Right curve not indicated, Lesotho

2 Unprotected drop, Honduras

3 No provision for vulnerable road users, Benin



this way they can take a fresh look at a road project without the distraction of having been involved in the design. The audit will be carried out by road safety engineers who, through practice, will have gained experience in identifying potential hazards, treating them and later monitoring the results.

RESPONSIBILITIES

A safety audit is not a comprehensive check on the technical aspects of the project. It does not check whether design standards have been followed. The designer is responsible for ensuring that technical standards are followed and in special cases where departures from standards are necessary, the designer is obliged to point these out clearly. The audit will not check whether structures such as bridges can safely take the loads that may be imposed on them. It is an assessment of the road safety aspects only. The road design team remains responsible for all technical aspects and continues to report to the project manager on these matters.

Since an audit involves one set of professionals checking the work of other professionals, this calls for much diplomacy and respect. Auditors must understand the background to design decisions and avoid commenting on any issue other than safety. Road designers whose work is being audited should

accept that the audit team may be able to improve on the safety aspect of the design to the benefit of everyone. The audit process brings specialist advice into the design process – it is not a test of the competence of the road designers.

Road designers must be given an opportunity to respond to the findings of the audit team, but the decision as to whether or not to adopt the team's recommendations rests with the project manager.

STAGES OF AUDITING OF A PROJECT

The earlier a project is audited, the more scope there is to make improvements. In projects where there is a choice of route or standards, or there are known safety problems, the design team should discuss these matters with the client (for example SANRAL or the particular province authority) at the earliest opportunity. The main audit is done after the detailed design has been completed. Any changes to the design arising from the audit ought to be incorporated before the project goes out to tender. In some cases there will not be time for this, and any major changes or additions will have to be carried out by means of variation orders. It is conventional to refer to the audit stages as follows:

Stage 1: Feasibility

Stage 2: Preliminary design

Stage 3: Detailed design

Stage 4: Pre-opening

Stage 5: Monitoring

COSTS AND BENEFITS

There is some concern that a road safety audit will increase the cost of the project, but this is rarely the case. Most changes involve minor issues, e.g. signing, marking and adjustments to the layout. These improvements are not costly if they are adopted in the early stages of the design process. A British study has suggested that one third of possible future accidents at road improvements could be prevented by a road safety audit. If the impact on costs is likely to be significant, the audit team will have to consider whether the cost is justified by the likely savings in accident costs and the matter may need to be referred to the client.

In countries where road safety audits have been routine practice for over 20 years, the practice is being extended. It is generally understood that safety audits have been highly cost-effective. As road accidents are normally considered to contribute to a loss in Gross Domestic Product (GDP) of 3–5%, a one-third reduction in road fatalities may be very advantageous to South Africa's economy. Hardly any other intervention in society can boast of contributing 1–2% of GDP, but road safety audits can! □





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ESSAY

Research and Practice

INTRODUCTION

Two formal papers, one published in the UK and the other in South Africa, have appeared in their respective professional journals, both written by full-time researchers, but canvassing somewhat different aspects of the research environment. They both comment also on the private sector's potential role in the research process, and in particular the sector's role in introducing research findings into practice.

The earlier paper, by Professor Barry Clarke of Newcastle University, entitled "Research: The hidden power of UK construction", was published in the ICE proceedings of May 2007 and set down a record of research conducted at universities in the UK over a recent period of years. In the course of his comments, however, Professor Clarke expressed fairly strong views on the construction element of the profession, stating, among others, that "UK research academics are recognised as international in their outlook and whose performance is well above average, despite below-average support", and that therefore "construction professionals should take advantage of this hidden resource on their doorstep".

The second paper, entitled "Technology for Infrastructure Development: Is South Africa well positioned?" by a group of researchers in South Africa's CSIR (Rust et al), was published in the SAICE magazine, *Civil Engineering*, of October 2009, but canvassed a somewhat different theme. It focused on the rather unsatisfactory present state of both infrastructure and infrastructure research in the country, on the importance of research into SET (science, engineering and technology), and also on sev-

eral other imperatives: to increase research funding, to create a national forum for discussion of infrastructure problems, and to bring the private sector fully into "the innovation chain."

This essay is written from the viewpoint of a non-researcher and apparently a "construction professional" in Professor Clarke's terms, but it ventures to discuss some of the points raised in both the above-mentioned papers, in particular those relating to the private sector. The Clarke paper created initial interest in the topic, but its criticisms of the private sector cannot with any accuracy or justification be canvassed in any detail from afar. This essay will tend to concentrate therefore on the CSIR paper and present-day R&D in South Africa.

CONSTRUCTION PROFESSIONALS

It is perhaps necessary to clarify the term "construction professionals" used by Professor Clarke but not defined by him. For purposes of this essay the term has been deemed to include all persons or organisations engaged either in design or in construction in the private sector, whether contractors, consultants, or present-day combinations and variations of the two.

On the other hand the CSIR paper uses the term "private sector" that could include not only "construction professionals", but also a different and important element of the sector, namely the manufacturers of the industry's machines and materials. Companies like Caterpillar and Lafarge, for instance, are but two well-known examples of the many manufacturing companies and mega-companies in this category, most of them needing neither outside encouragement nor state-funding in order

to promote and sustain their research efforts. Their research programmes are determined by the market and are enacted on a high-technology level as a matter of good business practice. However, although they have contributed enormously to the advance of both design and construction in the profession, the manufacturers' activities in the research field fall outside the scope of this essay.

Reference to the "private sector" in this essay will therefore be confined to the "construction professionals" as defined above.

THE CSIR PAPER

The paper raises three separate matters of interest with regard to the role of the private sector in the research process and its funding:

- a national forum to discuss and promote the role of R&D in the creation of infrastructure
- potential danger of the country becoming a "technology colony" if insufficient interest is taken in infrastructure research
- state-supported research bodies to form R&D partnerships with the private sector

The topics are interrelated in some respects, but each of them will be canvassed separately in the discussion that follows:

Proposed National Forum

The many specialist disciplines that together comprise the civil engineering process make it unrealistic to house all its research needs within the compass of a single institute. South Africa therefore follows international practice by providing for such research through a CSIR institute, departmental research units and universities. Those bodies have, however, made little effort in the past to adopt any sort of uniform approach with regard to each others' programmes.

In its desire to boost funding for infrastructure therefore, the CSIR paper proposes that "a national forum for infrastructure R&D could assist in ensuring synergy between government departments and between government and the private sector in terms of managing the R&D portfolio for South Africa". The proposal certainly breaks new ground, but seems to have the ring of some sort of high-level formal meeting that might carry official weight. The CSIR, however, offers no detail of the forum's proposed powers and method of operation.

In the light of their proposal therefore it might be relevant to set down a fragment of the CSIR's own history, when a somewhat

smaller-scale "forum" had in fact functioned for several years within one of its institutes.

During the early 1960s the CSIR's NITRR (National Institute of Transport and Road Research) established and administered a body known as the Road Research Advisory Committee (RRAC). This committee comprised, by invitation, Directors of Roads from the five provinces, equally senior officials from National Roads, City Engineers, Professors of Civil Engineering, representatives from consulting engineers and contractors. Meetings were held twice a year in order to hear and discuss not only NITRR's proposed and current programmes, but also a series of reports from the CSIR's Steering Committees on the more technical aspects of materials and design.

Although apparently rather large and diversified the committee managed to produce informal, open and frank exchange of views on research projects and policy – possibly the synergy that the CSIR paper now envisages. RRAC however issued no resolutions, budgets or decisions and appeared content to provide information to its members and to accept their comment – on occasions rather robust.

By virtue of their senior status and experience, the high-level officials tended to dominate proceedings at the earlier meetings, but the non-governmental members quickly managed to overcome their initial apprehension to contribute their own specialist expertise to the discussions. Furthermore, those same members also reported back to their respective organisations, so that the entire public and private road-building establishment was able to be kept informed on NITRR's priorities and programmes. An added and useful bonus for the private sector also comprised the personal contacts created at the sessions – the door had been opened both to NITRR and to the top bureaucracy of the road-building fraternity.

Regrettably RRAC has now disappeared from the scene, and the same fate might incidentally also have overtaken a similar committee that operated in NBRI. If the present-day CSIR is serious therefore in attempting to create contacts and partnerships with the private sector – in their words "to ensure that the full innovation chain from invention to commercial application is addressed" – it is difficult to understand why it has not followed the example of its predecessors. Their paper fortunately seems now to be taking a step in the right direction.

As an aside and in the course of argument, RRAC experience might relate in some way to Professor Clarke's criticisms of construction professionals. RRAC exemplified for instance

how collaboration and contact could work successfully, but the initiative to form RRAC emanated from NITRR and not from the private sector. The Clarke paper laments that first-class research receives little support from the UK's construction professionals, but, with respect and at some miles from the scene, it might be asked whether the UK academics ever thought of making efforts to present their findings and possible innovations separately to the construction professionals, or alternatively, whether the academics were of the opinion that publication of their findings in prestige journals would suffice as a promotion effort?

Returning to the "national forum" concept and based on RRAC experience therefore, it would seem that an essential first task at this time, and before any type of official forum is formed, would be to sound out the reaction of research bodies to the "forum" proposal. There might well be opposition to it. Certain research units might regard their particular efforts as too confidential for disclosure, others might fear losing their independence, resent interference or possibly fear criticism of their programmes.

It is therefore suggested that calling for a "national forum" be preceded by formation of an informal committee run more or less on the lines of the former RRAC. The committee should include the total research community in government departments – not only those cited in the CSIR report – and the universities. In fact, the private sector might not be required initially, because of possible inter-departmental strife and also confidentiality problems, and the sector's time of entry into the debate could possibly be delayed until the preliminary stages produce some sort of consensus. First items on the agenda would probably comprise the national forum concept and the general advisability of a unified approach.

When and if those and other potential hurdles are overcome the committee could begin to debate the detail. The proposed structure and purpose of such an informal committee might, however, be criticised as being able to produce nothing but a "talking shop". In fact a "talking shop" should be its initial objective – to allow the entire research community to debate

the CSIR proposal fully and frankly before taking precipitate action on a matter that could substantially affect the future of some of its components.

Technology Colony

The CSIR paper warns that "continued lack of investment in infrastructure-related R&D will place the sector in the situation of a 'technology colony' which makes the country dependent on international SET resources for the sector's needs". On this matter it might again be relevant to take recourse to history, relating not to research experience, but to that of the private sector.

From the very early days of its industrial and mining progress South Africa has had to depend on importing technological talent from industrial western Europe, and later the USA, in order to install a modern infrastructure. Early in the 1950s, for instance, a number of well-established foreign companies entered the country to join the infrastructure surge that was then in its initial stages, some of the companies operating on their own and others entering into partnership with local groups. Most of those companies stayed in the country for several decades and left only when the poor political climate threatened sanctions against South Africa, and attractive infrastructure projects with better prospects were being offered world-wide.

During their stay the companies had, however, made a positive impact on the local industry in terms of design, construction and the handling and administration of contracts, and their withdrawal during the 1980s was obviously a setback. It is therefore good news at this time that the new political dispensation has brought back foreign companies in greater numbers and from a greater number of countries around the world. The local industry and profession will stand to gain from the inflow, despite increased competition.

Admittedly such a direct result from foreign expertise is more easily achieved in day-to-day practice of design and construction than it would be in the case of R&D. Moreover, the CSIR is correct in affirming in its paper that South Africa has its own special research problems – technical, environmental, even social and political – that are best identified and solved with local

talent. Nevertheless, an infusion of foreign talent into research should probably do the local research establishment no harm.

Local companies might even find it necessary occasionally to commission research from foreign organisations, especially at this time when it seems to be agreed that the South African research effort is apparently functioning at a rather low ebb. The “colonising” researchers would then inevitably co-opt local researchers or research bodies into their operations and some of the “colonisers”, like their private enterprise colleagues, might even decide that they could find a future here. A great deal of technology transfer and R&D expertise could easily result.

There seems to be no reason for R&D from abroad to be feared or frowned upon, especially while the local research effort is busy reviving itself. In fact it should be welcomed.

Partnerships

A further recommendation from the CSIR paper is to form partnerships between the public and private sectors, a relationship which might not be quite as simple, beneficial and peaceful as it sounds. The difficulty that arises is that R&D tends to result in innovation and invention, both of which could lead to filing of patent applications and then onto problems with regard to ownership of intellectual property.

The public sector research establishment should know that construction professionals, although they themselves carry out little or no fundamental research, are vitally interested in innovation and invention (or should be if they wish to stay in business). Few of them would admit to a static or conservative mindset in that regard. In fact, from the dawn of the railway age in the 19th century that brought civil engineering into prominence (the IT revolution of its age) right until the present day, contractors and engineers have produced inventions and innovations that have made a marked contribution to progress of the profession and industry. The 20th century for instance saw the invention of two new construction materials, pre-stressed concrete and mechanically stabilised embankments, both invented by engineers from designer/contractor backgrounds. Both inventors, however, ensured that their intellectual property was properly in order before starting to cooperate in trials with the authorities, and both eventually succeeded in establishing their own companies that eventually operated world-wide.

In any event, not only the private sector, but all publicly-financed research bodies and the universities are nowadays well aware of the value of owning intellectual property, and, like the private sector, are sensitive about their own inventions and take care to protect them. Partnership agreements between private and public sectors that cover invention and innovation are therefore obligatory in virtually all cases in order to protect both sides and to avoid dispute.

In a number of cases, however, the parties could avoid expensive and complicated agreements on intellectual property. The private sector in particular often prefers to enter into confidentiality agreements with researchers rather than into patent agreements – a simpler and less controversial procedure, but to a certain extent favouring the inventor or entrepreneur who would get full royalties from an invention that eventually proves commercially viable. On the other hand researchers themselves might also prefer the confidentiality-agreement route that imposes on them few, if any, investment obligations and no financial risk.

The public sector research establishment should know that construction professionals, although they themselves carry out little or no fundamental research, are vitally interested in innovation and invention (or should be if they wish to stay in business). Few of them would admit to a static or conservative mindset in that regard. In fact, from the dawn of the railway age in the 19th century that brought civil engineering into prominence (the IT revolution of its age) right until the present day, contractors and engineers have produced inventions and innovations that have made a marked contribution to progress of the profession and industry. The 20th century for instance saw the invention of two new construction materials, pre-stressed concrete and mechanically stabilised embankments, both invented by engineers from designer/contractor backgrounds

Some form of agreement is, however, always advisable, even in apparently straightforward partnerships. Human nature can lose some of its humanity in disputes about money. Brilliant, patentable and profitable ideas might suddenly arise during apparently routine investigations, and such possibilities need to be legally covered, making it essential to anticipate problems that R&D could bring forward.

SUMMARY AND FINAL COMMENTS

The CSIR paper has proposed basically that grants for research in civil engineering not only be boosted threefold, but that the appeal for such a considerable increase should come from a united front of all research bodies and the private sector through a national forum. Their proposition appears to be reasonable, but it is possibly premature. In any event, a sudden leap in funding would hardly be advisable or practical in the present state of the research establishment, thus allowing ample time for talk.

It has therefore been suggested in this essay that discussion and debate on the topic should first of all be conducted less formally within the research community in order to canvass all opinions. The total research establishment has never before cooperated in this fashion, so that sounding out of problems and getting to know each others' viewpoints seem to be essential before any formal approaches are made to the authorities and the providers of research grants.

All state research departments and universities need to be included in any projected future deliberations, however,

not only those departments cited in the CSIR paper. For reasons of confidentiality the private sector, consultants and contractors, might not be required at initial discussions, but the sector could obviously play a part later in respect of obtaining opinions on present research, potential new research projects and especially problems already requiring investigation in practice.

It is suggested furthermore that the CSIR itself is the most suitable body to organise and coordinate such discussions, formal or informal. As a centrally-controlled state-controlled organisation, and probably able to act in terms of its official mandate, it is ideally placed to connect with all research bodies in order to discuss and decide with them the priorities and a method of approach. The CSIR might also become the body that could not only indulge in "blue skies" research (as distinct from research directly related to practice) but should also, through its many contacts, be able to report back to the profession on international advances in both theory and practice. In any event it is high time for the CSIR to re-establish its previous contacts and cooperation with its colleagues in the private sector, whether or not the proposed forum becomes a reality.

Lastly, the authors of the paper are to be congratulated on their initiative in raising the topic. It remains for them, however, to take the next steps forward, bearing in mind the essential need to obtain from the start the opinions and, ideally, the backing of the entire profession. ▣

Just-in-time design

The Gautrain heralds a new era for transport technology

AS ONE OF THE FIRST and largest design and build projects of its kind in South Africa, the Gautrain Rapid Rail Link (GRRL) has been a pilot scheme in many respects.

Having been fast-tracked to facilitate broader infrastructure expansion and 2010 FIFA World Cup construction goals, the two-phase development of the project started in September 2006 and is

① Phase 1 of the cut and cover; traffic to be diverted over this portion for Phase 2

scheduled to be completed by the end of March 2011. Typically, a state-of-the-art rapid rail system of this magnitude could take up to 14 years to build.

HHO DESIGN AND CONSTRUCT

Donovan Hugo, Director and Project Manager at HHO Africa Consulting Engineers says, “It is new for South African consultants to work on design and construct with the just-in-time design requiring you to modify and optimise as you go along.”

HHO Africa, in joint venture with Ingerop, was appointed to undertake the preliminary design of two of the Gautrain design sections, namely Marlboro–OR Tambo International Airport, and Eeufees–Pretoria–Hatfield, followed by the detailed design and construction monitoring phases for the 8,1 km route from Eeufees to Pretoria and Pretoria to Hatfield.

Their 40-month contract includes work on the most technically complex sections in terms of space constraints as the majority of the route has to be designed and built within a cutting 12 m wide and 8 m deep, bordered on the one side by residential and commercial properties, and on the other by an operating South African Rail Commuters Corporation line (SARCC – now PRASA, i.e. Passenger Rail Agency of South Africa).

Says Hugo, “The design of the linear works was very challenging, particularly from Pretoria Station to Hatfield Station as the GRRL had to be fitted in next to the SARCC/PRASA line, all within the existing rail reserve. The Gautrain has to pass through five operating Metro railway stations, necessitating careful planning of the construction activities as the trains and stations had to be operational for the duration of the construction. In order to thread the GRRL through the existing



The Ben Schoeman Freeway, along which the N1 transfers traffic from Johannesburg to Pretoria (Tshwane), carries 300 000 vehicles per day and is purported to be the busiest stretch of road in South Africa. Taking traffic accommodation into account was an important consideration in the decision to use the cut and cover tunnelling method on this portion of the Gautrain project



urban infrastructure, 6,4 km of earth-retaining walls, three viaducts, three rail-over-rail flyovers and 18 other bridge structures are required. Wherever possible, precast M-beams have been used for the bridge superstructures for fast track construction. There are 11 km of precast beams, 230 km of prestressing strands and 1 600 rubber bearings.

TECHNOLOGY AND SOFTWARE

Civil Designer software was used for the rail and road alignments and to calculate the earthworks profiles. The details of the various types of earth-retaining walls, as well as rail clearances, were also determined. At most sections there was only 200 mm clearance. The surveyor on site also used Civil Designer, which made the interchange of alignment and designer files so much easier.

HHO, which was appointed in September 2006, was involved in the review of the preliminary design, draft design, draft construction and construction design phases. Says Hugo: "We had regular meetings with the contractors, as well as design review meetings. It has been an iterative design process taking into account many elements, such as cost and constructability."

During the preliminary design phase, the HHO project management team investigated various options for the part of their section of the Gautrain (Cut and Cover 6) that passes underneath the Ben Schoeman Freeway.

CUT AND COVER

The Ben Schoeman Freeway, along which the N1 transfers traffic from Johannesburg to Pretoria (Tshwane), carries 300 000 vehicles per day and is purported to be the busiest stretch of road in South Africa. Taking traffic accommodation into account was an important consideration in the decision to use the cut and cover tunnelling method on this portion of the Gautrain project.

This involved building a temporary three-lane bypass in order that the rail crossing below the freeway could be trench-excavated for the construction of the in situ tunnel portals. While the rock underneath the freeway was

- ② A section of the 250 m long portal
- ③ Aerial view of the alignment into and out of Pretoria station showing the viaducts and flyovers

being excavated, lateral supporting pillars (18 m exposed depth) were put in place to stabilise the road and prevent the trench from collapsing. In this way traffic flow could continue undisturbed on the temporary deviations.

To achieve this stability, HHO used temporarily anchored piles. Hugo explains, "As we went down, we had to put anchors in to keep the piles back. We would then monitor the deflection of the piles to check for any lateral movement. We constructed the portals in situ and then reinstated the road using vertical reinforced earth panels and backfill."

Hugo worked closely with the software programmers at Knowledge Base (the developers of Civil Designer) to customise the alignment functions specifically for the Gautrain project.

He says, "We've learnt a huge amount in terms of document control and managing the design process, as well as coordinating the project management aspects. The GRRL comprises all aspects of civil engineering and is

one of the most challenging projects we have done to date."

THE FUTURE OF THE GAUTRAIN AND RAIL TRANSPORT

Rail transport in South Africa will enter a new era with the opening of the Gautrain, which will introduce a modern inter-city commuter rail service connecting Johannesburg and Pretoria, with six trains per hour running 18 hours per day between the two cities at speeds ranging between 160 and 180 km per hour.

Travelling time between Johannesburg and Pretoria will be approximately 35 minutes and 12 minutes between Sandton and OR Tambo International Airport.

There are mixed projections on how effective the Gautrain will be in alleviating congestion. However, James Chakwizira, Senior Researcher at CSIR Built Environment says, "The Gautrain is not meant to be a substitute for road-based transport and was never conceived as an alternative to urban mass public transport. In a way, the Bus Rapid

Transit (BRT) proposal and initiative answers to that call, as well as complementing the Gautrain project."

"It is important also to view the GRRL as a starting point and as a line from where other lines and extensions are to be developed. This lends credence to the concept of the Gautrain as the anchor rail line from which inner and outer ring rapid rail link lines would integrate with the mass transport system in the Greater Johannesburg area."

Public transport relies on densification to make it work and the future land-use patterns around the station will be vital. The Gautrain project office is working with municipalities to create station-development plans around the ten Gautrain stations and is actively promoting changes in land use around stations since much of this land is at present underdeveloped.

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Drainage management behind mechanically stabilised earth walls

ONE METHOD OF DESIGNING and constructing a retaining wall is using mechanically stabilised earth. A number of similar technologies fall under the heading of mechanically stabilised earth walls (MSEWs), each claiming to be distinct or having a particular advantage, but essentially performing or using similar theory in their respective design processes. The application of all MSEW technology relies on good construction practice, careful selection of backfill soil, compaction and moisture control without neglecting drainage management.

During the construction phase there is an inherent risk of rainwater ingress into the backfill, with accompanying risks regarding consolidation, pore water pressure, and cavitation or piping. As a result the cladding system or panels may become distorted or displaced.

Rapid removal of water from retaining walls can be executed with geosynthetic materials, concrete drains or pipes. To drain excess quantities of surface water requires consideration of at least the following factors: estimated volume of water, gradient/slope, duration of collection, and exit/discharge conditions. The purpose of managing this draining function is to keep the backfill of an MSEW structure as dry as possible during and post construction.

The following are two examples of MSEW mining projects successfully completed in Africa:

Iduapriem, Ghana – Terramesh (gabion) system
Klipspruit, Ogies in Mpumalanga – Macforce (concrete panel) system

1 Gabion facing – MSEW at Iduapriem

IDUAPRIEM – GHANA

This primary crusher tip wall for Anglo Ashanti in western Ghana offered both options and challenges – an abundance of good quality rock that is kept in spoil dumps, and a high rainfall. The structure housing the crusher is 30 m high and is founded 11 m below ground level. Before designing the tip wall, drainage aspects of the foundation and backfill, and surface water accumulation and runoff were thoroughly investigated. With the availability of an excess amount of processed crushed rock and a large local labour force, it was suggested that an MSEW solution using a soil reinforced gabion design would take advantage of the resources and address the water/drainage aspects.

Although the Tarkwa region has a high rainfall – in the order of 1,5 metres annually – water drainage management of this MSEW is successful, due to its permeable facing, coupled with careful attention to the compaction control of the backfill and the channeling of surface water runoff. This project at Iduapriem demonstrates the successful drainage of surface water by using the ability of the whole gabion surface to expel excess water, thereby keeping the backfill and the wall dry.

KLIPSPRUIT COAL MINE – OGIES

A different water regime was found at the project site in Ogies, where a coal mine required a ramp to be built on coal



2 Drainage curtain behind panels at Klipspruit

deposits overlaying a horizontal bed of laterite. During the excavation stage a shallow water table and poor quality top soil, overlaying the stiff laterite layer, were found. This confirmed the interpolations of the geotechnical investigation. The MSE design therefore required a system to cope with the expected consolidation of fill and possible settlement. An MSE solution that could cope with possible differential settlement was chosen and, in addition, a stronger pioneer layer of up to 2 m in thickness was placed on top of the stiff laterite deposit at the outset. This pioneer layer created a workable platform and also improved the foundation bearing capacity and conditions. The MSE design also specified a 500 mm gravel curtain directly behind the cladding panels of the wall to provide maximum dissipation of all the surface water runoff during construction and to provide a drain for water to escape from any future ingress of water into the backfill. Great care was taken with the selection of the backfill which was a blend of rock spoil and sandstone - this delivered a well graded material with good frictional characteristics. This choice also contributed to reducing water penetration, as it compacted well and sealed off the layer while work proceeded during the rainy season.

CONCLUSION

Management of the water regime, maintenance of the efficacy of the drainage system, and attention to as many associated contributing factors as can be made known to the designer and constructor certainly assist in coping with water related conditions to keep MSEWs functioning to their best capacity.

► INFO

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Infraset and Transnet develop second-generation transition beam

A second-generation transition beam has been designed and developed by Transnet Freight Rail (TFR) and Infraset Railway Products. Transition beams smooth out the difference in resilience between normal ballast-mounted rail track and the concrete-mounted track found in tunnels.

The new beam represents a substantial advance over its first-generation counterpart, jointly developed by TRF and Infraset for the Richards Bay coal line nine years ago, in that it is much easier to produce and simpler to install. Two beams (four in all) have been placed at each entrance to the only tunnel on the Sishen/Saldanha ore (Orex) line, the northern end being situated at Elands Bay on the Western Cape coast.

Transition beams comprise individual sleepers which are post-tensioned to form a single ladder-shaped beam. Rails are secured to the beams with Pandrol fastenings. Because they rest on ballast, the beams provide intermediate resilience, approximately 50% less than normal ballast-mounted track and 50% greater than the concrete-mounted track used in tunnels.

Josia Meyer, senior engineer track technology at TFR, says the net effect of stepping resilience up or down depending on the direction of the train is that the frequency of maintenance required at tunnel entrances is reduced from three times to once annually. This in turn minimises line closures and improves overall productivity.

► An installed transition beam at the entrance/exit to the tunnel on the Sishen/Saldanha ore line at Elands Bay

“Track assemblies at tunnel entrances, which are not protected by transition beams, are less able to withstand the additional vertical and horizontal forces generated by trains as they move from concrete-mounted to ballast-mounted track, and vice versa. These additional forces accelerate ballast deterioration by a factor of three, hence the higher maintenance requirement,” says Meyer.

As TFR intends increasing freight volumes on the line from the current 45 million tons to 60 million tons a year, any avoidance of line closures will have a direct impact on tonnages hauled.

Attie Coetzee, civil maintenance manager on the Orex line, says the line runs the longest production trains in the world.

“These stretch to 4 km and comprise up to 342 wagons and 11 locomotives (three electrical plus eight diesel units) on each. The Orex line is undergoing continual improvements. For example, ten years ago its maximum carrying

capacity was only 18 million tons,” Coetzee continues.

Sizwe Mkhize, product manager of Infraset Railway Products, says the joint development of a local transition beam first began in 1999 when Transnet decided to replace a Japanese beam, which precluded tamping of the ballast situated immediately beneath it.

“This first-generation replacement beam proved successful in reducing the amount of maintenance required on the coal line and the improvements now incorporated in the second-generation beam were installation and production driven,” explains Mkhize.

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MARKET PERSPECTIVE

Breaking the impasse: unlocking infrastructure and housing

A CRITICAL NATIONAL CONSTRAINT in the delivery of housing remains the lack of availability of bulk infrastructure. The increasing disparity between bulk municipal services capacity and the services demands of housing delivery has emerged as a critical constraint in South Africa.

Since the late 1970s patterns in municipal service infrastructure investment have shown a persistently growing gap between the rate of expansion of infrastructure reticulation networks and the rate of creation of bulk infrastructure. This investment gap has reached critical proportions in many municipalities, effectively placing a drag on economic growth and the ability to deliver housing with a dignified level of services. As a result, South Africa can expect a relentless rise in communities deprived of service delivery, in informal settlements and in worsening absorption of the urban poor into the formal economy.

Given the structural weaknesses experienced in its municipal infrastructure delivery approach, South African is in dire need of smarter solutions to meet the housing and services investment challenges of its urban development process.

Bigen Africa, in partnership with ABSA Bank, is actively working with municipalities in finding new ways to realise synergies in integrating housing delivery while solving critical city-wide infrastructure shortfalls. In the process ABSA/Bigen Africa are engaging their partners in the financial services sector to provide project finance to a wide range of municipal infrastructure projects. Through its dedicated Infrastructure Development Services (IDS) unit, Bigen Africa is finding smart solutions for delivering housing and infrastructure within the South African institutional and legislative context.

By preparing projects carefully, ABSA/Bigen Africa have been able to overcome key constraints currently experienced by

the conventional development approach to housing and infrastructure. Four critical advantages have been achieved for municipalities by following a fresh approach in the way municipal infrastructure is planned, funded and implemented:

- **Upping the pace of delivery.** Through integrated project scoping, unnecessary delays in the pace of infrastructure delivery, which are typical of incremental project delivery, are avoided. In structuring and raising project finance the limitations of grant availability and constrained municipal balance sheet borrowing capacity can be overcome. In addition, Bigen Africa has invested significant resources in finding practical and legitimate approaches to implement projects within the regulatory and institutional municipal environment. In this manner the backlog in creating municipal services infrastructure can be reduced through an enhanced rate of service delivery expansion, and the traditional grant funding and borrowing capital availability is complemented.
- **Broadening the availability of development funding for municipal infrastructure creation.** An increased flow of development capital to local government remains a critical success factor in addressing infrastructure needs. In an economic environment of reduced state revenue, it is necessary to complement existing flows of capital grants to maintain and even increase the pace of delivery. Importantly, most banks, pension funds and investment companies target infrastructure and housing, with many having created dedicated funds to channel investments into these focus areas. In the current context, very few such funds reach the municipal sector due to the lack of transactional scope. However, if the right kind of project finance solutions are structured, there is potential for massive additional capital flows to the municipal sector.

In a range of municipalities in, inter alia, Gauteng, the Northern Cape, Limpopo and the Eastern Cape, housing delivery has been long delayed due to a lack of bulk infrastructure availability. These municipalities are already benefiting from the development approaches being jointly facilitated by Bigen Africa and ABSA. Collectively, these partnerships are proving that the lack of government funding and weak municipal borrowing capacity should not be insurmountable obstacles in realising large-scale housing and infrastructure projects in an affordable manner

■ **Optimising the developmental impact of infrastructure investment on the poor.** There is significant scope to leverage private sector capital to benefit the poor sustainably through infrastructure investment. It is fiscally appropriate to direct private capital investment in public infrastructure to those projects that can be sustainably funded through alternative development finance mechanisms. By structuring such projects to make provision for cross-subsidisation of the poor, state resources can be significantly complemented. It follows that such an approach would create additional scope for public budgets to focus on meeting the infrastructure needs of the poor. In addition, such an approach serves to relieve the pressure on municipal budgets to fund infrastructure projects when the money could be better spent on other forms of development funding. In the process municipalities will create additional budgetary scope to fund much needed social infrastructure.

■ **Building municipal fiscal capacity.** Through an integrated approach to project design and risk mitigation, municipal fiscal capacity is strengthened by limiting operating liabilities while removing critical institutional weaknesses in revenue management and operational efficiency. In addition, integrated project design ensures that municipalities can incorporate previously unfunded projects through cross-subsidisation. Municipalities thus achieve greater affordability, stronger cash flows and reduced risks.

In a range of municipalities in, inter alia, Gauteng, the Northern Cape, Limpopo and the Eastern Cape, housing delivery has been long delayed due to a lack of bulk infrastructure availability. These municipalities are already benefiting from the development approaches being jointly facilitated by Bigen Africa and ABSA. Collectively, these partnerships are proving that the lack of government funding and weak municipal borrowing capacity should not be insurmountable obstacles in realising large-scale housing and infrastructure projects in an affordable manner.

Bigen Africa's strong capacity in technical matters, development finance and institutional knowledge has enabled it to structure feasible project finance solutions in rural areas, small urban centres and major metropolitan settings. By finding smarter solutions, we have opened up a new world of possibilities for our partners. The teaming of a skilled technical services provider, a committed commercial bank and a willing government points the way for future housing and infrastructure solutions in South Africa and beyond. □

STANDARD (SANS 517) FOR LIGHT STEEL FRAME BUILDING PUBLISHED

LIGHT STEEL FRAME BUILDING is a well-known building method in Australia, the US and Europe, and has been in use for more than 50 years. This technique – an alternative to traditional methods using bricks and stone – can be used for a wide range of low and medium-rise residential and office buildings, but has only become established in southern Africa since 2007.

Because light steel frame building is not yet included in the National Building Regulations as a conventional building method, plans have to be submitted for approval, together with a rational design by a competent person, normally an engineer. As SANS 517 *Light steel frame building*, can be used as a basis for the design, its recent publication is important news for architects, civil engineers, developers and all others planning to use light steel frame building methods.

John Barnard, the Director of the SA Light Steel Frame Building Association (SASFA), and technical specialist responsible for SANS 517, comments on the standard as follows:

“Light steel frame building has been described as ‘intelligent building’. Apart from the speed of construction – and hence earlier occupation – LSFb offers structurally sound buildings and logistical cost advantages. It offers buildings that comply with the insulation requirements of SANS 204, *Energy efficiency in buildings*, neat and crisp finishes are possible, and reports have been received of cost savings of up to 20% compared with conventional masonry building. Wastage of building materials is minimised.

“Despite the recession, 20 000 tons of high-strength galvanised steel were used for light steel frame building projects using this technique during 2009, a growth of 10% over 2008 volumes. As there was a decrease of ca 230% in low-rise building projects over the same period, this clearly shows that more construction firms are turning to this technique.

“The advantages associated with this method are that the buildings are environmentally friendly and structurally sound; time savings of up to 30% can be achieved compared

with conventional building; and they offer good thermal insulation and superior finishes.

“Light steel frame building is a building method, and should not be confused with prefabricated or ‘kit’ buildings. It has been described as ‘off-site’ building because a lot of the manufacturing takes place in factories, and the components are then assembled on site.

“It consists of structural wall panels and/or trusses, assembled using cold-formed steel sections made from thin-gauge, high-strength galvanised steel sheeting. Sections are joined together – typically in a factory – using rivets or self-tapping screws to form structural wall panels and/or roof trusses which are then transported to site for erection on foundations or floor slabs.

“Similar to timber frame construction, the wall frames are clad externally and internally on site with a range of alternative cladding materials, with services (electrical and plumbing) and insulation material installed in the wall cavity. Any type of roofing material can be used,” John concludes.

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NEW STRUCTURAL TUBE STEEL LAUNCHED

THE ASSOCIATION OF Steel Tube and Pipe Manufacturers of South Africa (ASTPM) and the Southern African Institute of Steel Construction (SAISC) have announced the launch of grade S355 steel for structural tube. The new grade, which replaces the previous 300 standard, has been designed using international best practice and complies with the minimum standard based on EN10219 Part 1.

“This will make a significant difference to the structural steel tube industry as, for

1 Many of the leading tube and pipe manufacturers are investing in state of the art machinery specifically to handle the new grade S355 steel for structural tube. Pictured here is one such machine

the same amount of steel as the previous 300 standard, higher loads can now be resisted,” says ASTPM executive director Colin Shaw. “This will render steel tube much more competitive against both other steel profiles and other construction methods like reinforced concrete.”

SAISC executive director, Dr Hennie de Clercq, says that S355 will help considerably in the process of encouraging architects and engineers to, inter alia, build high-rise structures in steel rather than concrete. “We will be promoting strongly the advantages of tubular steel and steel in general for these structures,” says de Clercq.

ASTPM’s Technical Committee chairman, Franco Mordini, believes that the new grade will help tubular steel become even more recognised for its inherent advantages. “Apart from its widely acclaimed aesthetic properties, it is becoming increasingly accepted that closed tubular sections, when concentrically loaded in compression, offer considerable savings to structures. Also, tube is inherently the most efficient form for resisting torsion loads, which may also be applied during the fabrication and erection processes,” says Mordini. “Importantly, tube does not have a weak axis and the steel is optimally distributed.”

Mordini says further that one of the crucial advantages of S355 is that tubular steel is now in line with the grades used with hot rolled steel



products. "This obviates the complication of having to specify different grades for different products, thus making it easier for architects and engineers to specify tube for an entire job, or portion thereof, rather than either being used sporadically or not at all."

Meanwhile, in anticipation of the expected increase in demand for tubular, some of the ASTPM's members have invested significantly in cutting and preparation equipment which is able to make the most of this new grade. "These improved plasma and laser cutting technologies have eradicated many profiling difficulties and will contribute to simplifying the fabrication process of steel components made out of tube, and hence the competitiveness of tubular product," says Shaw.

The official launch of S355 took place in February 2010 in Cape Town, Durban and Johannesburg, where the keynote address was given by world-renowned tubular specialist, Canada-based Dr Jeffrey Packer. The launch was followed by a one-day seminar on Tubular Design and Construction led by Dr Packer.

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THE WORLD'S SMALLEST AND LIGHTEST HYDRODEMOLITION UNIT

CONJET AB IS EXTENDING its comprehensive range of leading hydrodemolition equipment with the launch of the latest revolutionary high-pressure hydrodemolition Conjet Nalta Jetframe 101. The Conjet Nalta is the world's smallest and lightest hydrodemolition unit. It replaces and robotises the dangerous and far less productive hand-lancing method of hydrodemolition, as the "Nalta" operator remotely controls all functions of the Jetframe 101 a safe distance from the working area.

The Conjet Nalta Jetframe 101 is very flexible and versatile as it mounts, climbs and operates on standard scaffold tubes, and as there are no electrical sensors it can also operate under water. All components are small, light and easy to carry and position. The cutting head weighs 14 kg, the feed beam section 6 kg and the hydraulically controlled step units, which are fixed to each end of the feed beam and automatically climb up and down standard scaffold tubes, weigh 9 kg each. The trolley-mounted hydraulic control unit weighs 90 kg.

Safety was paramount in the design of the Conjet Nalta. "Nalta" is a colloquial term used in Vilhelmina in Lapland in northern Sweden to denote something very small. Nalta operators do not need the "spaceman-type" bulky and heavy protective clothing that is essential when using awkward and cumbersome hand-held lances.

The Conjet Nalta will eliminate the accidents that can occur with the hazardous hand-lancing operations and has already proved to be considerably more productive in pre-launch contract trials. "We are replacing the dangerous hand-held lancing operations and making them safer with our new and revolutionary Nalta Jetframe," says Conjet vice-president Lars-Göran Nilsson. "Contractors that have so far used the Nalta during on site contract trials have been very impressed with its safety and performance. With a hand lance pump of 120 kW, generating 250 N reaction force, production will be between two to three times higher than with a hand lance. Because the Nalta can withstand a greater reaction force of 600 N, compared to 250 N for a hand-held lance, higher-powered pumps can be used, increasing productivity even further by up to five to six times. The Nalta is also very easy and quick to set up and can work continuously, so there is far less downtime compared to hand lancing, where operators have to stop and rest



1 The Conjet Nalta Jetframe 101 replaces and robotises numerous hand lance applications, improving safety and increasing productivity

every 20 minutes or so. Hydrodemolition with the Nalta is also far more controlled, uniform and accurate, and selectively removes only damaged concrete. It will prove ideal for those contractors currently using water jetting hand lances."

The Nalta Jetframe 101 is supplied with high-pressure water from a standard hand lance pump. The operator controls all movements of the Nalta Jetframe 101 from a handheld portable control box and can operate on flat as well as curved surfaces with a radius as small as 400 mm. The Nalta Jetframe 101 is powered by a trolley-mounted hydraulic unit that only needs to be connected to a single-phase 10 A 230 V electrical supply.

The Nalta Jetframe 101 is primarily intended for the hydrodemolition of concrete, but is also suitable for other applications, such as cleaning and de-scaling of steel. A different power head with a self-driven rotor is available as an option that can be used for numerous surface preparation tasks. For example, the Nalta Jetframe 101 can achieve HB 2½ grade cleaning on steel surfaces when operating at pressures exceeding 2 500 bar.

The Nalta Jetframe 101 system consists of a feed beam with an oscillating cassette, hydraulic unit and a remote control box. The oscillating lance, fixed to the cassette, travels along the 1 m long feed beam, which can also be extended with two extra sections to a maximum length of 3 m. The angle of attack of the lance changes direction when it hits the manually set turning points at each end of the feed beam. This eliminates the need for electric sensors, enabling the unit to be used underwater. Due to the innovative patent protection only one set of hydraulic hoses is required for controlling all functions

of the Nalta Jetframe 101, including oscillating lance angle and cassette movements.

The feed beam is attached at each end to a patented hydraulically controlled step-climbing unit. The two step units fix onto and automatically climb up and down standard scaffold tubes after each traversing pass of the cradle and lance. The step units can also operate on scaffold tubes bent to a minimum radius of 400 mm, making the versatile Nalta Jetframe 101 ideal for working on curved as well as flat surfaces.

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ENSURING WATER FOR OUR FUTURE

THE ETHEKWINI WATER reticulation system's aged leaky pipes currently lose 90 000 kilolitres daily, which has prompted the municipality to invest in a multi-million-rand replacement programme to ensure that it has sufficient water for the future.

According to eThekweni Water and Sanitation (EWS) head Neil Macleod, the Non-Revenue Water branch has embarked on a focused programme to identify and treat the problem at source.

1 Durban University of Technology students undergoing training for field measurements. The eThekweni Non-Revenue Water Reduction Programme provides experiential training and a bursary scheme for seven students at any one time

"With eThekweni's water demand rising, and leaks increasing due to the old crumbling pipe infrastructure, we realised 18 months ago that quick action was essential to prevent demand exceeding supply," he said.

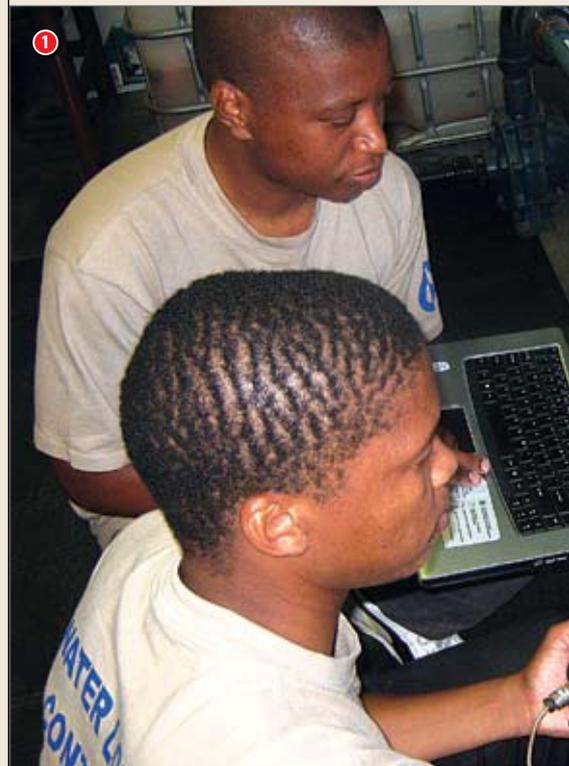
The municipality purchases 880 million litres of water daily, but currently only sells 590 million to consumers. In the 2009 financial year R37,3 m was invested in various water loss reduction projects and another R65 m has been budgeted for the current year.

Among the 16 dedicated interventions for curtailing water loss is the extensive Asbestos Cement (AC) Pipe Replacement programme. Macleod said these projects have cost R1,6 bn, with the new pipes expected to provide at least 50 years of leak-free service to the municipality.

EWS has also improved the customer billing service to minimise anomalies. More than 3 020 water meters that were installed in the 1970s and earlier have already been replaced and the new meters are monitored to ensure accurate measurements.

"Pressure management has proved to be one of the most effective interventions. By reducing the water pressure, we can reduce water loss by 70 million litres each day, and every R1 m invested in pressure management translates into a R3 m saving on water losses," continued Macleod.

He said that a year into the programme improvements in the water losses are already evident, which eThekweni attributes to the persistent efforts to replace the mains, reduce pressure and detect and repair leaks and bursts.



"Although too early to confirm a trend, we are delighted to see the benefits and encouraged that our work is reaping rewards. This is no quick fix, but in 18 to 36 months, we should see the cumulative benefit of the work being done," he said.

The municipal goal embraces annually reducing leaks such that within a decade the loss can be held steady at 23%. According to World Bank publications, this would place eThekweni Metropolitan Municipality's water system among the top 35% in the developed world and among the top 15% in the developing world.

By implementing all the planned interventions, bulk water purchased over the next five years is projected to be held steady in spite of a 2% annual growth in actual consumption. Reducing the water lost through leaks will maintain the average daily demand.

"People only notice when things go wrong and we are working to minimise leaks. If the public assists by reporting leaks and water bursts on the toll-free number 0801 313 013, we can significantly reduce water loss," concluded Macleod.

Additional information

In reducing water losses during the 2009 financial year, EWS:

- carried out leak detection surveys on 15 000 km of pipes
- repaired 7 000 leaks
- designed 62 new pressure-reducing valves (PRV) and commissioned 16 new PRVs
- installed 87 PRV failure-detection devices
- commissioned five advanced PRV controllers



- replaced 864 km of AC pipes.

In the current financial year to June 2010 EWS will:

- install 350 PRVs
- commission 100 advanced pressure-control devices
- conduct leak detection and repair activities on 18 000 km of reticulation
- replace 700 km of existing AC pipelines
- upgrade all custody transfer meters that are used to purchase water in bulk.

The long-term goals for the programme are to:

- ensure that all standpipes, water dispensers and electronic water tariff units are metered
- reduce the average zone pressure from 550 to 400 kpa
- continue replacing all consumer meters older than 20 years (\pm 21 000 meters per year)
- meter all water consumption in informal areas and reduce wastage
- regularise all illegal connections (estimated to be 28 000).

► INFO

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DHV SIGNS GIANT CONTRACT FOR INDONESIAN SANITATION PROJECT

DUTCH CONSULTANCY AND engineering firm DHV and its Indonesian subsidiary PT MLD have signed a contract to undertake a giant sanitation project in Indonesia. The Urban Sanitation Development Project will develop sanitation strategies and manage studies, designs and construction supervision services for waste water, urban drainage and solid waste in 80 cities. The contract, worth €10 million, runs until the end of 2014 and is being financed by the Dutch Ministry for Development Cooperation through the Dutch Embassy in Jakarta.

There is an urgent need to tackle sanitation issues in Indonesia. Jan Oomen, DHV's project leader, says, "Indonesia has a population of around 230 million. Only 1% of the people have access to sewerage and 40% do not have environmentally safe private or public toilets at their disposal. This poses serious health risks. The Indonesian government

underwrites the Millennium Development Goals and wishes to improve the situation significantly."

The project is part of the Indonesian government's Accelerated Sanitation Development Programme (known by its Indonesian acronym PPSP). The programme aims at improving waste water, urban drainage and solid waste infrastructure and services in 330 cities over the coming five years. Investments under PPSP are currently estimated at US\$5 billion by the Indonesian government. Oomen states, "We expect that this amount will need to be doubled if local governments opt for more structural long-term solutions for their still fast-growing cities."

- 1 Floating toilet, Banjarmasin, Indonesia
- 2 Garbage and settlement along a riverbank in Indonesia

The Indonesian National Planning Board is the formal client of the project. The bulk of the contract concerns guidance and assistance to the cities that will be developing their strategies and implementing their plans themselves. Over the past four years DHV has worked on similar assignments for twelve cities and three provinces. According to Oomen, "We can put our fieldwork experience and international knowledge of waste water, urban drainage and solid waste management to good use in this new contract. Our work has already resulted in the establishment of our approach as model for the national programme. It is the Indonesian government's intention that its backlog in urban sanitation services, as compared with the Millennium Development Goals, will be largely resolved after those five years. The preceding project, Indonesia Sanitation Sector Development Programme (under the management of

the World Bank) was also funded mainly by the government of the Netherlands.

► INFO

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UPDATED PIPE AND PORTAL CULVERT HANDBOOK FOR ENGINEERS AND SPECIFIERS

THE PIPES (Concrete Pipe, Infrastructural Products and Engineering Solutions) division of the Concrete Manufacturers Association (CMA) has issued an updated version of its *Precast Concrete Pipe and Portal Culvert Handbook*. Revised by independent pipes consultant, Alaster Goyns, it is available in hard-copy, on CD or from the CMA's website.

Aimed at designers and specifiers working for municipal and consulting engineers, the handbook provides the basic guidelines on correct usage, selection and specification of concrete pipes and culverts. Installers will also find it useful.

CMA director, John Cairns, says the handbook mainly covers pre-construction and design aspects including the basic theory on determining product size, strength and durability, as well as some theory on special features. Chapter headings include product classification, hydraulics, loads on buried pipelines, concrete pipe strengths, bedding, pipe jointing, flotation, sewer corrosion, portal culvert strengths and field testing.



The formulae, diagrams and tables provided are adequate for most product applications. However, they are by no means all-encompassing and the book provides a list of useful publications for further reading.

Three groups of standards are applicable to precast concrete pipe and portal culverts, namely:

1. Codes of practice, which detail how product size, strength and durability should be selected
2. Product standards, which prescribe what product requirements have to be met
3. Construction standards, which prescribe how products should be installed. (A companion publication covering installation aspects in greater detail is available from the CMA.)

The handbook is based on the relevant Standards South Africa (SANS) codes and standards and all products covered comply with the relevant SANS specifications. These product standards ensure that finished products meet the necessary performance requirements and all use the same basic layout:

- Scope
- Normative references
- Definitions
- Materials used
- Requirements to be met
- Sampling and compliance
- Inspection and test methods
- Marking
- Normative and informative annexures

There are no standards for determining the size or durability of concrete pipes. However, the standards for the installation of concrete

1 Concrete stormwater pipes, which were used extensively in the Gauteng Freeway Improvement Project, await installation under the switch ramp on the N3 north



pipes are included as sections in the SANS 1200 series for standardised specifications for civil engineering construction.

All factories operated by CMA's PIPES division member companies have approved quality management systems to ensure that products comply with the relevant SANS specifications. Global Conformity Services (GCS) issue manufacturing permits and do frequent audits to ensure that standards are being maintained. These standards are periodically reviewed.

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WSP COMPLETES MAJOR ROAD REHABILITATION PROJECT IN THE FREE STATE

WSP SA Civil and Structural Engineers (Pty) Ltd has just completed a 20 km section of one of the biggest road rehabilitation projects ever to have been awarded by the Free State Department of Police, Roads and Transport. The R315 million project entailed the rehabilitation of a section of Route R59, comprising roads P10/1 and P83/1 between the Vaal River at the Free State/Gauteng border and the N1 in the Free State.

The R59 corridor encompasses the road linking Sasolburg, Parys and Viljoenskroon with Goldfields, Orkney and North West. The road will offer an alternative to the N1 toll road, linking Sasolburg with Vereeniging, Witkop/Daleside, Klip River, Meyerton, Alberton, Vanderbijlpark, Sebokeng and Evaton, and these areas via Bothaville, Hoopstad, Bultfontein and Bloemfontein to the Eastern and Western Cape. It is estimated that the corridor carries some 7 100 vehicles per day in the vicinity of Sasolburg, many of them related to the manufacturing, agricultural and mining industries, as well as SASOL itself.

Work commenced on the N1 Sasolburg section of the corridor, including the P83/1 Freeway section, in January 2007, and practical completion was certified on 23 September 2009.

The project comprised the rehabilitation and widening of some 20 km of provincial road, with 8 km being upgraded to a four-lane



1 *Rehabilitated section of Route R59 between the Vaal River at the Free State/Gauteng border and the N1 in the Free State*

undivided freeway standard, the rehabilitation of 2,5 km of conventional freeway, widening of three major river bridges, the rehabilitation of five road-over-road and road-over-railway bridges, and widening of more than 200 drainage structures. Intersections were upgraded to make them safer and an 18 mm layer of ultra-thin friction course (UTFC) was applied to the road surface to reduce water spray and traffic noise.

Prior to the upgrade the road was extremely narrow and rutted, resulting in blinding water spray, and featured many potholes and failures together with dangerous edge drops. Statistics showed that between 1994 and 2003 there were 267 accidents on this stretch of road.

The professional team that was retained by the client, the Free State Department of Police, Roads and Transport, represented by the Chief Director: Roads, Mr Anton Troskie, included the consulting engineers, a joint venture comprising WSP SA Civil and Structural Engineers represented by engineer Andries Bester and resident engineer Hennie Landman, and LMV Consulting Engineers and Town Planners. The main contractor was a joint venture between Basil Read, ThulaHohle and Set Time Plant Hire, represented by the contractor's project manager, Tyrone Gilbert.

During the course of the project, WSP SA Civil and Structural Engineers employed ten local people as technical assistants in its laboratory and provided three students with holiday work. During the course of the road rehabilitation project, 377 new jobs were created and a total of 695 workers received training in an assortment of areas. All workers attended workshops on HIV/Aids

and drug abuse awareness. Training was also given on first aid and fire fighting; health and safety and risk assessment; flag men and road safety; plant operators and small plant; scaffold erection and inspection; concrete placing; steel fixing and formwork; road-works and surveys; and managerial training for emerging contractors.

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MAPEI REPAIRS HIGHWAY PILLARS

GLOBAL ITALIAN-BASED group Mapei, a leading manufacturer of chemical and adhesive products for the construction industry, recently completed a project in Italy involving the repair of concrete surfaces of highway pillars.

Mapei, represented locally by Mapei South Africa, was contracted as part of a larger project to modernise and upgrade the entire Italian highway network. Work was completed on the Rio Verde viaduct located along the Cisa A15 Motorway in Pontremoli, Tuscany.

The viaduct comprises two decks which rest on pillars, supported by abutments. These pillars are the second highest in Europe, with two of them reaching more than 140 metres. The surface of the pillars deteriorated due to a combination of factors, such as carbonation and erosion by chlorides in de-icing salts used during winter. This causes the reinforcement

rods within the pillars to rust, leading to cracking and flaking of the concrete.

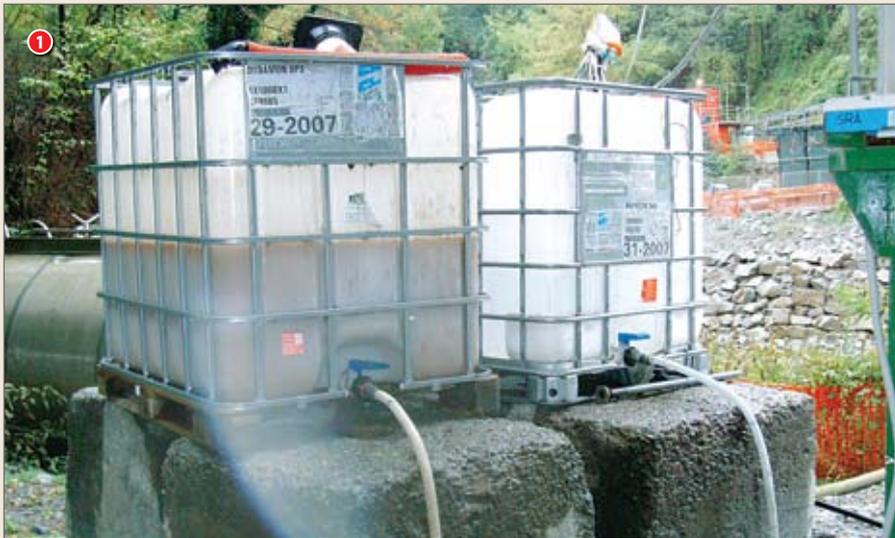
For the two highest pillars, restoration included the removal of between 8 and 12 centimetres of the deteriorated concrete through a hydro-scarifying process, laying a reinforcement mesh and then repairing the damaged portions using self-compacting concrete poured into formwork around the pillars.

The project was not without challenges, which related specifically to materials, access and safety.

The restoration of the two central pillars was most complex due to the fact that the special rheological properties and long workability times of the self-compacting concrete needed to be considered in all weather conditions. Mapei thus developed a dimensionally stable, self-compacting concrete. The self-compacting concrete was mixed using STABILCEM SCC cementitious binder, which is particularly suitable for making concrete mixes with no shrinkage. It is therefore ideal for beams, kerbs, viaduct pillars, bridge superstructures, hydraulic works and dry docks.

Mapei selected products that were developed specifically for large site operations and for restoration of concrete structures. EXPANCRETE expansive agent, MAPECURE SRA curing admix, and DYNAMON SP3 super-plasticiser were used for making self-compacting concrete. These materials met the specific requirements of the project and ensured that operating times and productivity were maximised. For final protection of the two pillars, MAPELASTIC, a two-component flexible cementitious mortar, was applied.

The second challenge, namely access, was overcome by the construction of a specially designed platform, which also assisted in overcoming the third challenge of worker safety. Operations were mostly automated with the use of the platform, ensuring complete safety



1 Mapei supplied a number of products, such as DYNAMON SP3 super-plasticiser, for restoring the pillars of the second largest viaduct in Europe

and high productivity. The platform met all operational requirements, such as moving formwork, reinforcement rods, scarifying equipment and perforation materials to high levels. It was also able to perform different operations simultaneously or in sequence even in adverse weather conditions. The automation of operations also ensured that the quality of the process was consistent, working times and costs were optimised, and waste was reduced.

The entire project spanned a period of two years and was completed successfully, meeting all safety and material requirements. Due to the composition of the concrete, the repaired pillars have a perfect surface, with no bubbles, cavities or gravel clusters. The concrete's excellent mechanical properties lead to longer life and also ensure that no carbon dioxide or chlorides are able to penetrate the columns.

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ELEMATIC SA ACHIEVES SABS MARK IN FAST AND SMOOTH AUDIT

ELEMATIC SA (ESA) recently achieved certification from the South African Bureau of Standards (SABS), which entitles the company to apply the SABS mark to all its products.

Customers using any product which bears the SABS mark are assured of a consistent level of quality and reliability. In attaining this certification, ESA has provided its customers with further peace of mind via this assurance of quality.

Elematic hollow core concrete slabs are manufactured at ESA's facility in Benoni, using state-of-the-art technology imported from Finland. ESA's ability to rely on such technology, and on cutting-edge research and development from Elematic in Finland, has always been beneficial to the business. Referring to achievement of the SABS mark, ESA director Craig Webber points out that, because all Elematic equipment is designed to produce hollow core slabs that meet the EN European Standard, the process was made considerably easier.

When an organisation applies for certification, the SABS sends out an auditor to carry out an audit which essentially tests for conformity against a specified standard, namely SANS 1879:2004. This is usually in the form of a quality management system. ESA began implementing the ISO 9001:2008 quality management system some 18 months prior to the SABS audit, and all processes and procedures were therefore tested against this standard. The company contracted independent consultant Francois Beneke of Interlock Quality Consulting Network to assist in the implementation of the ISO 9001 system.

Beneke, who is a concrete technologist, was able to assist ESA in ensuring that the ISO 9001 system was fully and correctly implemented. He explains that this is not always a quick or simple process, and that for most companies, it takes between 12 and 18 months to implement an ISO or similar quality management system. Most companies need auditing from scratch, and often systems and processes need redesigning and reorganising before they comply with the requirements of the chosen quality

management system. "One has to produce evidence and keep a detailed paper trail in order to meet the requirements for the SABS mark," Beneke comments.

He says that it requires a committed effort from management in any company to implement the system well, and comments that the close-knit team at ESA worked very well together. "We looked at everything right down to the computer software to ensure that the products comply with South African structural standards. We also tested everything against the EN and SABS norms," he says. By the time the SABS audit was carried out, ESA's systems had been tested thoroughly and the audit and certification process went far faster than expected. The audit involves an inspection of all the ISO 9001 documentation as well as physical tests of the product. All the different slab types manufactured by ESA were tested, and all were deemed eligible to bear the SABS mark.

Beneke points out that apart from the obvious benefit of attaining SABS approval, implementing a quality management system such as ISO 9001 has numerous spin-off benefits for any business. "In the manufacturing process, it is important to be able to get the quality of the products right first time. ISO 9001 requires that companies carry out a self-assessment on a regular basis, in line with the requirements of good corporate governance. If a mistake occurs, the system requires a detailed analysis that looks for the root cause of the problem, which means that one cannot just go for a quick-fix so-

1 *Elematic hollow core concrete slabs now bear the SABS mark*

lution," he says. All this adds up to a streamlined business which is ultimately more competitive and well run. Customer satisfaction surveys are also important, as they feed back into the self-assessment process.

Overall, the certification process at ESA went far faster than expected. "We went through a very quick assessment process. We didn't need to implement any new procedures in order to attain approval," says Webber. Beneke concurs, saying that the overall result at ESA has been excellent. "This is a good product and the audit was carried out in a comparatively short period of time. The team effort at ESA made a definite difference," he comments.

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CONSTRUCTION SECTOR DISPLAYS OPTIMISM IN THE EYE OF FINANCIAL STORM – KPMG SURVEY

OPTIMISM IN THE CONSTRUCTION sector abounds despite falling demand in commercial and residential building work and in the face of

the global financial crisis according to a global KPMG survey concluded in November 2009. The survey covered construction companies in 30 countries with revenues ranging from US\$250 million to US\$5 billion.

Geno Armstrong, international sector leader of KPMG's Engineering and Construction practice says that "there is a perception that the global financial crisis has devastated the construction industry. While it certainly has had a significant impact on the way these companies do business, we've found that they view these conditions as an opportunity to get leaner. When the recovery does finally arrive, these companies should be well-prepared to succeed."

Fifty-three percent of global respondents stated that their backlog volume of jobs has gone up or stayed level. The picture was similar with profits in the current order backlog with just 44 percent of global respondents claiming a decrease. Contractors in Africa, Europe and the Middle East appear to have been hardest hit with 54 percent indicating their projected profit rates have declined.

Gavin Maile, KPMG Africa Construction Partner, indicates that "in South Africa profit rates for new contracts are coming under pressure, especially in the housing sector, with numerous contractors bidding on each contract. While globally the future for the industry promises huge government stimulus packages with the potential to reinvigorate the infrastructure market, it is unclear how much money will be made available for infrastructure and where it will find its way," says Maile. "This is a matter of much debate in the boardrooms of engineering and construction



companies around the globe. The situation in South Africa is slightly different, where a significant number of infrastructure projects had already commenced before the downturn, especially in the critical areas of power, roads and football stadia."

Only 12 percent of global respondents believe that proposed government stimuli packages will bring a significant increase in opportunities over the next 24 months. Although contractors in the Asia-Pacific region had the most confidence in government packages, 82 percent of respondents are expecting a moderate or significant increase in opportunities over the next 24 months with 43 percent of respondents from Africa, Europe and the Middle East believing that such stimuli will have no demonstrable impact in that timeframe. In contrast, 73 percent of American respondents are expecting some stimulus impact by mid-2011.

"The direct impact of South African infrastructure projects, on the other hand, is already flowing through the local economy," says Maile.

The survey reveals further optimism in the construction industry's ability to retain

its talent in difficult times. While 35 percent of global respondents have not reduced their workforce, very few contractors appear to have felt the need to cut workforce costs via salary reductions, reduced working hours or unpaid sabbaticals. It was found that 28 percent of respondents have taken no action at all with regard to workplace reductions.

Whilst the 2008 survey identified a general talent shortage in the industry, the 2009 respondents show a great reluctance in shedding valued employees. "Construction companies are becoming increasingly conscious that this is a talent-focused sector. South Africa has experienced the return of many talented individuals, and foreign nationals are seeking work here. When the recovery does come, engineering and construction companies want to make sure that they have the right skills and experience ready for the opportunities available," adds Maile.

The survey indicates that the recession, rather than forcing cutbacks, as would be expected, has in fact intensified contractors' efforts to manage the risks associated with projects. What was once considered

a weakness in the sector is now receiving renewed attention.

Seventy three percent of respondents to the survey say they have put even more effort in the last 12 months into due diligence and checking the financial stability of clients. The majority of respondents reported carrying out more in-depth analyses of performance risks on 'mega projects' and devoting considerable time and resources to improving risk management through investments in systems and more comprehensive assessment of cash flow, compliance and safety risks.

KPMG's global construction survey, *Navigating the Storm*, can be found at the following website:

www.kpmg.com/buildingandconstruction

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SAICE AND PROFESSIONAL NEWS OUT AND ABOUT



A fresh look at the SAICE Project Awards

SAICE PROJECT AWARDS 2010

This year we at SAICE are stepping up our game by taking a fresh approach to the annual Project Awards. With a unique line of attack, we will be looking at ALL projects: big, small, medium, unusual – you name it, we'll have a section for your project to compete in.

There is also a category for 2010 stadiums where each stadium, whether built from scratch or upgraded, will receive an accolade for the skilful work done to make the World Cup possible.

We call on members to enter all types of projects for the 2010 competition. Keep looking out for more details on our

website (www.civils.org.za). Once you find yourself on the home-page, go to 'Events and Awards' on the top menu bar, and select 'Awards' on the drop-down menu.

Should you need any further information, you are most welcome to call or e-mail me (see contact details above).

AQUATAN-SAICE AWARDS EVENT 2009

The 2009 Aquatan-SAICE Awards Function, which took place on 15 October at the Forum on The Campus grounds in Bryanston, Johannesburg, was sponsored by Aquatan (Pty) Ltd – sincere thanks again to our main sponsor for supporting the event.

Co-sponsors were Vital Engineering (for entertainment) and SSI (for beverages). Heartfelt thanks go to these two co-sponsors as well. Together these three sponsors ensured that guests could enjoy a stylish evening out.

The diverse guest list comprised members, sponsors, students, industry leaders, and members' clients rooting for their submitted projects. Judging by the happy pictures of guests enjoying the evening, the event was indeed a great success.

We would like to make the 2010 event an even greater success *so please enter your projects and be part of this exciting year!*

Seen enjoying themselves at the Aquatan-SAICE awards function

1 Piet Meyer, Managing Director of Aquatan (main sponsor of the event), addressing the audience

2 Mike Kühne chatting to Riaan Brits – both are from Cobiax

3 Allyson Lawless (left), SAICE President in 2000; Ria Botha, wife of SAICE Executive Director Dawie

Botha; and Kate Lawless, Allyson's daughter

4 Francois Retief, left, Adrian Bergh and Llewellyn Pike

5 Jeffrey and Lucia Mahachi - Jeffrey is Executive Director, Technical and IT, at the NHBRC

6 Barbara Jensen, Communication and Marketing Executive, Gautrain

7 Ozuem Okecha, civil engineering graduate (UCT) and currently working for Murray and Roberts

8 Trevor Ncalo, chairman of the SAICE Johannesburg Branch, with Chris Herold, chairman of the SAICE Water Engineering Division, and his wife Marina 



Some thoughts about ethics in civil engineering

INTRODUCTION AND BACKGROUND

The philosophical study of ethics is an in-depth look at the nature of the core ideologies that any civilized society is built upon: good and bad, right and wrong, justice and injustice. Ethics maintains the stability of society without imposing regulations for every act (Sober 2005). It is also vital to note that ethical decisions have extended consequences.

It is important that professions follow specific regulations in accordance with ethics. In the medical profession this becomes very important, especially when the decisions of professionals affect those who cannot defend their own rights. This is clear in the Dr Stephen E Breuning case. Dr Breuning, an esteemed researcher in the field of mental health, reported on experiments that were never carried out and knowingly published scientific papers that were fraudulent (Boffey 1987). The amorality of the decisions made by Breuning not only affected the research of other scientists and the legitimacy of scientific literature, but also, more severely, influenced the treatment of mentally ill patients, many of whom were denied beneficial drugs (Boffey 1987). Breuning was initially exposed by a colleague, Dr Sprague, who noticed inconsistencies in his research. Due to the reluctance of university and Federal agencies to investigate the allegations of misconduct on the part of Breuning (Sprague 1993), three years later Sprague exposed the case to the media. Subsequently, disciplinary measures were taken against Breuning. However, Sprague suffered certain consequences such as public criticism, intimidation, harassment and refusal of access to research funding.

Civil engineering can have a significant impact on the environment and society. The Breuning case illustrates

various ethical issues that are important for the civil engineering profession today. In particular, it highlights the plight of whistle-blowers and the responsibility of professionals to maintain the integrity of the profession and those who practise it.

SOME LESSONS FOR CIVIL ENGINEERING IN SOUTH AFRICA

South African civil engineers are bound by certain codes of ethics and may be disciplined if they do not follow them. A prominent code of ethics is that published by SAICE (2008). This code focuses on the quality of decisions, justice, equity, consequences, responsibilities and the conflicts that arise as a result of good or bad decisions.

Most professions that provide a service to society are bound by certain ethical codes to protect public health and safety and this is morally right. Ideally, issues of professional misconduct should be resolved within the scientific community in which they have arisen (Sprague 1993). When all internal resolution channels have been exhausted, it becomes the responsibility of a whistle-blower to expose the misconduct in order to protect the public. This was the case when Sprague publicly exposed Breuning's fraudulent claims in research. Sprague suffered intimidation and harassment by many but, in the end, the rights of vulnerable mentally retarded patients were more important.

A civil engineer is therefore duty bound to protect public health and safety and to report to the appropriate authorities any possible risk to the public from a client, employer, engineer or other service provider who fails to follow good practice during the construction of infrastructure. If such a case is known about and not reported, the



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- 3 Ivanka Bulovic
- 4 Nicole Teeling
- 5 Nafisa Bhikho

civil engineer may be disciplined, especially in instances where public safety has been compromised. This is a difficult decision to make for many civil engineers as many whistle-blowers have had their reputations ruined and have been alienated from their communities as a result of publicly exposing wrong in their workplaces. It is therefore good practice for institutions such as SAICE to provide conducive avenues for ethical issues in practice to be amicably and speedily resolved without the need for publicity.

Many civil engineering researchers are funded and supported in their research. Indeed, the future of engineering rests with this endeavour – research. In the SAICE Code of Ethics it is stated that members should “contribute to the collective wisdom of the profession and the art of civil engineering and technology in which they practise” (SAICE 2008). However, when this contribution is fraudulent, it becomes more than a private issue as the consequences are often so great. As with the Breuning case, other people (e.g. civil engineers, decision-makers in government and scientists) may rely on the results presented and make

assumptions and decisions based on the wrong data. This had a severe effect in the Breuning case as the mentally retarded, who could not defend themselves, were the main victims of the fraud and suffered significantly. With civil engineering, society assumes that certain regulations are in place to thwart people intent on fraudulent research, and it is the duty of every civil engineer and the professional institution to enforce these regulations. It is important that society’s rights to safety and to benefit optimally from infrastructure are upheld, no matter what pressures are imposed by internal or external authorities.

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Many civil engineering researchers are funded and supported in their research. Indeed, the future of engineering rests with this endeavour – research. In the SAICE Code of Ethics it is stated that members should “contribute to the collective wisdom of the profession and the art of civil engineering and technology in which they practise” (SAICE 2008). However, when this contribution is fraudulent, it becomes more than a private issue as the consequences are often so great

Letter

ECONOMICS OF LABOUR-ENHANCED AND/OR LABOUR-INTENSIVE CONSTRUCTION OF ROAD PAVEMENT STRUCTURES

There is an urgent need to build the required capacity to tackle the immense task of rehabilitating or reconstructing South Africa's failing road network, which the AA currently estimates will cost more than R72 billion.

The current tendency to promote labour-enhanced pavement structures, with the objective of creating sustainable jobs and developing skills in the provision of road infrastructure, appears to be a short-sighted strategy.

The engineering fraternity has a responsibility to guard against politicians dictating inappropriate labour-intensive construction (LIC) methodology irrespective of the impact on quality or life-cycle costing, and hence the way in which taxpayers' money is squandered to achieve this objective.

The current notion should first be reassessed in terms of performance to date and expected life-cycle costing, compared with conventional road-building techniques.

Reported successes all relate to initial outcomes, viz number of jobs created, but not sustainability of jobs; training provided and access improvement, but very little about quality versus quality achieved and, more spe-

cifically, uniformity in quality actually attained. There is also no mention of the subsequent need for maintenance at a very early age, and no comparison with what could be expected from such pavements constructed using conventional road-building methods.

Unfortunately, experimental work in this regard, with all sorts of claims to fame, creates false impressions among laymen, including politicians, as to the potential ability of especially such "light pavement structures," using LIC methodology.

As an example, in the December 2009 issue of *Civil Engineering*, reference is made to one such community-based project. The pavement structure discussed comprises in situ material of unknown quality, reworked and compacted to unknown density, with no mention of potential macro or micro moisture regime, and covered with a 50 mm continuously reinforced 30 MPa concrete slab capable of carrying more than $1,0 \times 10^6$ equivalent 8 ton axles, based on Heavy Vehicle Simulator (HVS) test results! No mention is made of moisture-induced conditions also being assessed in the test, as formed part of such testing years ago!

The layman will gather that this solution may now be feasible for all subgrade conditions. He will also get the shock of his life

when, after a few years, due to inadequate cover, corrosion of the steel causes pop-ups in the road and subsequent disintegration of the slab. This technology actually stems from the ultra-thin layer inlay technique used abroad, but in that case using 120 MPa quality concrete.

It is often forgotten by even the engineering fraternity that a road pavement is a structure required to display certain inherent engineering qualities uniformly over its entire length, such as resilient moduli and shear resistance as appropriate for specific layers, in order to perform uniformly at an acceptable level of risk for a specific category of road.

To obtain the required quality uniformly requires a really critical appraisal of the construction techniques adopted.

In addition, where LIC has been implemented, the following problems have been experienced:

- The cost per kilometre of road has more than doubled.
- The rate of progress attainable is in the order of 10 to 20% lower than that attained with conventional road building methodology.
- Already, due to poor performance experienced in the northern provinces, some authorities (e.g. the Western Cape)

It is imperative that a survey of all these LIC projects be carried out country-wide by a panel of technical experts to objectively assess the actual performance and expected life-cycle costs of roads of various categories already constructed in this manner, and to advise government and the general public on the outcome

are insisting on using conventional road building techniques for base and surfacing.

- Unemployed labourers recruited from the local community for training in LIC methodology very often stay away at will or even disappear.
- Sustainability of jobs in a particular area is not possible, and at the end of the project other communities (even from adjoining wards in a metropolitan area) will not accept such trained people to operate in their area.
- More time is spent on police local labour requirements as per the contract document than focusing on technical matters.

It is imperative that a survey of all these LIC projects be carried out country-wide by a panel of technical experts to objectively assess the actual performance and expected life-cycle costs of roads of various categories already constructed in this manner, and to advise government and the general public on the outcome.

SAICE members should also be encouraged to report on their experiences to date.

I believe that government with its Expanded Public Works Programme (EPWP), as far as roads are concerned, is barking up the wrong tree. It

is targeting the often illiterate labour market, instead of the pool of jobless matriculants.

Stellenbosch economist Prof Servaas van den Berg (*Finweek* 2009) has stated that people between the ages of 20 to 24 represent 14% of the labour force, but 27% of people in this same age group are unemployed. These mostly literate, but unemployed, people should rather be allowed to develop skills in using modern road construction methodology. This would pave the way to build the required capacity to ultimately rehabilitate/reconstruct our failing road infrastructure timeously.

They in turn, operating at a higher skills level, would be able to earn better salaries and assist the state by caring for the ageing illiterate group.

A pragmatic strategy should be developed among all national, provincial and metropolitan road authorities to implement the required training in conventional road building methodology.

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New SAICE Fellows



▶ Dhiren Allopi



▶ Rod Blackhurst



▶ Dawie Erasmus



▶ David Erskine



▶ Lenn Fourie

Dhiren Allopi is Associate Director in the Department of Civil Engineering and Surveying at the Durban University of Technology. His academic qualifications include an NHD (Civil Eng) from the ML Sultan Technikon, Masters Dip Eng (Roads and Transportation) from Technikon Natal, Postgraduate Dip Eng from the University of Natal, Dip Datametrics (Computer Science & Info Systems) which was obtained cum laude from the University of South Africa, and a Doctorate Degree in Civil Engineering from the ML Sultan Technikon. He has over 30 years of combined industrial and academic experience. Dhiren's main area of specialisation is in the field of traffic and transportation engineering, and he is currently supervising 12 postgraduate students mainly in the field of transportation engineering. He has over 50 journal papers and conference proceedings to his credit.

Rod Blackhurst was born in Pretoria in 1944 and, after graduating from the University of the Witwatersrand, began working early in 1967 in the farm dam and irrigation section in Ninham Shand's offices in Cape Town. He left the firm in 1972 and, for the next five years, worked for a construction company before moving to Botswana in 1978, where he was employed by Sir Alexander Gibb and Partners. He rejoined Ninham Shand in 1980 and remained with the firm, where

he was involved mainly in water resources planning studies, until he retired as an Associate in 2009.

Dawie Erasmus graduated from the University of Natal, Durban, in 1978 with a BSc in Civil Engineering and a GDE in 1995. He started his career with the NPA Roads Department and joined Vela VKE Consulting Engineers in 1991, where he was appointed as Director in 2002. Currently he is Head of the Roads and Transportation Division. Dawie has over 30 years' experience in roads, transportation and project management. Prominent projects that he had been involved in include the upgrading of the Western Freeway with a public transport lane for eThekweni Municipality, the N17 Soweto to Nasrec Link Road for SANRAL, and the upgrading of the Gulu to Nimule road in northern Uganda.

David Erskine attended Maritzburg College, and thereafter attained a BSc Civil Engineering degree at the University of Natal in 1971. He then joined the Department of Water Affairs in their design office in Pretoria. After attaining his Professional Engineer status he joined Grinaker Construction Natal in 1981. One of the first contracts Dave was involved in was the incremental launch of the Umhlatuzana Viaduct on the N2. This was one of the first incrementally

launched bridges to be constructed in South Africa. He became a site agent with the company and was involved in numerous contracts in KwaZulu-Natal. In 1987 he started Erbacon Construction as one of the three founding members. Operating initially out of Dave's garage converted to office, the company rapidly grew and in 1991 premises were acquired in Glen Anil, Durban. With Dave as CEO of Erbacon Construction, the company became a recognised medium-sized contracting company in KwaZulu-Natal, undertaking a broad spectrum of civil engineering contracts. In 2007 the company listed on the JSE and the acquisition of Armstrong Construction was successfully concluded. The company has since merged with Civcon Construction, with Dave remaining as the CEO.

Lenn Fourie graduated from the University of Stellenbosch in 1974, joined the Cape Provincial Roads Department and became a "padmaker". After heading the geometric and traffic engineering sections, he became Director Design in 1998, assuming overall responsibility for all aspects of provincial road design, the materials laboratory and various technical support sections. He is extensively involved in the overall management of the Roads Branch, its annual budget, implementation programmes, policies, management systems, technical and liaison committees.



▶ John Gibberd



▶ Paul le Roux



▶ Brian Lewis



▶ Danai Magugumela



▶ Andrew Mather

John Gibberd graduated in 1973 and then joined the City of Cape Town in their Mitchell's Plain design and construction supervision office. Since joining HHO Africa in 1982 and obtaining his GDE in 1983, John has managed the Mthatha office and is currently the Director in charge of the Eastern Cape offices. Rural and urban road infrastructure and rural water supply are his fields of expertise. John has been involved in the upgrading of the R61 between Mthatha, via Port St Johns, to Lusikisiki, as well as the recently completed Ugie-Langeni (Phase 2) mountain pass.

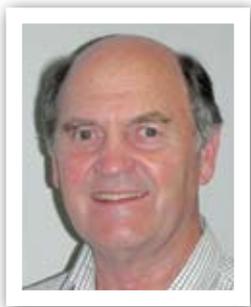
Paul le Roux started his bulk water career with the DWA in 1980. He then focused on water distribution and sanitation when he joined Keeve Steyn Incorporated in 1988. He has developed a keen interest in the application of life cycle management principles to pipe systems and has been involved with the planning, design, construction and rehabilitation of numerous pipe systems, also using appropriate trenchless technology. He then combined his design experience and project management skills to lead some major bulk water pipeline infrastructure projects since 2004. Paul is currently a Technical Director with Goba leading the water business unit.

Brian Lewis graduated from the University of Cape Town in 1973. He spent 14 years with Transnet, in various departments, before joining Soderlund and Schutte in 1987, becoming a Director in 1990. He specialises in structural engineering, as well as the provision of urban infrastructure, and hydrology. Brian was awarded a Confederation of British Industries Scholarship in 1986, gaining experience in industrial facility design in Stratford-upon-Avon. He has served on various committees of Consulting Engineers South Africa (currently on the membership committee). He also provides input, by invitation, in the basics of structural engineering to architectural students at the University of the Witwatersrand.

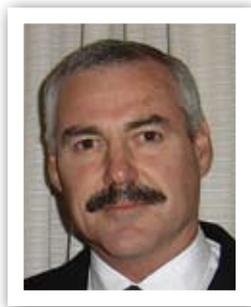
Danai Magugumela was born in Zimbabwe (then Rhodesia) and attended diverse schooling in Zambia, the USA and Italy. She earned BSc (cum laude) and MSc degrees in Civil Engineering from Prairie View A&M University and Texas A&M University in the USA, where she completed a thesis on pavement materials. After years in consulting engineering in South Africa, Danai became Project Manager in the Municipal Infrastructure Investment Unit (MIIU) where she was later promoted to CEO. Currently Danai is the CEO of BKS, a

leading multi-disciplinary consulting engineering firm. She believes in attracting and retaining women to the profession of engineering and the built environment. Danai serves on the Council of the University of Pretoria, and is a Fellow of the South African Academy of Engineering.

Andrew Mather was born in Malawi where he concluded his high school education. He moved to Durban in 1982 and obtained his civil engineering degree at the University of Natal. He was employed by the then Durban City Council as an engineer working on water supply and stormwater networks. In 1993 he was registered as a Professional Engineer. He obtained a B Com (Hons) degree from UNISA and was progressively promoted up the managerial levels to the position of Director responsible for the stormwater and coastal engineering function in the eThekweni Municipality. Since 2003 Andrew has been in a strategic management role within the municipality, responsible for the eThekweni coastline and river catchments. Presently he is completing a PhD on the risk and management of sea level rise and coastal erosion along the southern African coastline, and has been involved in coastal research and projects in South Africa, as well as in Namibia, Mozambique and Reunion.



▶ Peter Ocroft



▶ Greg Parrott



▶ Gons Poonan



▶ Les Thomson

Peter Ocroft graduated from Natal University in 1969 with a BSc (Eng). He worked for consulting engineers and contractors on a broad range of projects before becoming a Director of Henny & Associates in 1985 and subsequently an Associate of Stewart Scott Inc, before joining the City of Cape Town late in 1999. He is currently the Head of Special Projects in the City's Housing Department. Peter's keen interest in biodiversity and conservation of the natural environment is balanced by an appreciation of the need to provide a better place to live for the masses of underprivileged people in the city.

Greg Parrott matriculated from Northlands Boys High School in 1977, served two years of military service, and then registered at Technikon Natal (now Durban University of Technology) for the National Higher Diploma in Civil Engineering. He went on to complete the Masters Diploma in Technology, Civil Engineering (Structural) in 1985. Greg worked in the structures section of the Durban Corporation until being appointed as a lecturer in the Department of Civil Engineering & Surveying at Technikon Natal (now Durban University of Technology) in 1990,

where he presently holds the rank of Associate Director, and was appointed as Head of Department in January 2008. Greg has been an active member of the KZN branch committees of both the CSSA and SAISC for many years and has presented numerous CPD courses throughout the country for SAICE on both reinforced concrete, and structural steel design.

Gons Poonan graduated with a B Eng (Civil) degree from the University of Durban-Westville in 1977. During 1976 he worked as a student engineer for Savage and Lovemore on the Durban Outer Ring Road (N2-25) Project. After graduating, he joined the then Durban City Engineers where he spent the first three years in the housing, traffic and structural departments, before moving permanently to the structural division, progressing to Senior Engineer in 1984. In 1989 he left the Council to join AA Loudon and Partners, where he was promoted to Associate in 1991, Partner in 1994 and Managing Partner in 1997. He left the company in 2000 to establish Gons Poonan and Associates. In July 2003 the company merged with Goba, where Gons became a Director. Currently he is head of Goba's

Structures Division (including Bridges, Building and Civil Structures). He serves on Goba's Board and Executive Committee, and is Chairman of the company's Nominations Committee. Gons specialises in bridges and structures, with some of his most recent involvements being the new interchange on the N2 at the King Shaka International Airport, the Moses Mabhida Stadium in Durban and the incrementally-launched bridge at the N3-N12 Gillooly's interchange as part of the Gauteng Freeway Improvement Project. Gons is also a registered Construction Project Manager.

Les Thomson graduated from the University of Cape Town in 1972, and then worked for the City of Cape Town. In 1975 he joined HHO as an assistant resident engineer on the N2 near Humansdorp, and in 1978 he moved to the Structures Division of HHO in Cape Town where he spent a number of years designing bridges. Les has also enjoyed the structural design of a number of other projects, such as the Table Mountain Cableway, and various buildings and water retaining structures. He is currently the Director responsible for structural design in HHO Africa. □

Date	Event and CPD validation number	Presenters	Contact details
17 – 18 March Johannesburg 5 – 6 May Durban 16 – 17 August Cape Town	Technical Report Writing <i>SAICEbus09/00427/12</i>	Karl Von Buddenbrock	Sharon Muger cpd.sharon@saice.org.za
23 – 24 March Johannesburg 20 – 21 May Cape Town 22 – 23 September Durban	Finance for Non-Financial Managers <i>SAICEfin10/00638/13</i>	Tony Lydall	Dawn Hermanus dhermanus@saice.org.za
15 April Johannesburg	Position yourself as an impactful professional <i>SAICEot09/00629/13</i>	Candice Tomlinson	Sharon Muger cpd.sharon@saice.org.za
20 April Johannesburg 25 May Cape Town 10 August Johannesburg 21 September East London	Reinforced Concrete Design to SANS 10100-1 <i>SAICEstr09/00432/11</i>	Greg Parrott	Sharon Muger cpd.sharon@saice.org.za
29 April Johannesburg 7 May Cape Town 14 May Durban 21 May East London 28 May Port Elizabeth	Structural Failures <i>SAICEstr09/00596/10</i>	Tony Aimer	Sharon Muger cpd.sharon@saice.org.za
21 April Johannesburg 26 May Cape Town 11 August Johannesburg 22 September East London	Structural Steel Design Code to SANS 10162: 1-2005 <i>SAICEstr09/00513/12</i>	Greg Parrott	Sharon Muger cpd.sharon@saice.org.za
11 – 12 May Cape Town 25 – 26 May Port Elizabeth 27 – 28 July Bloemfontein 7 – 8 September Durban 12 – 13 October Cape Town	Handling Projects in a Consulting Engineer's Practice <i>SAICEproj08/00404/11</i>	Wolf Weidemann	Dawn Hermanus dhermanus@saice.org.za
13 – 14 May Cape Town 29 – 30 July Bloemfontein 9 – 10 September Durban 14 – 15 October Cape Town 17 – 18 November Johannesburg	Business Finances for Built Environment Professionals <i>SAICEfin08/00405/11</i>	Wolf Weidemann	Dawn Hermanus dhermanus@saice.org.za
31 May Cape Town 13 September Pietermaritzburg 23 November Johannesburg	Bridge Maintenance <i>SAICErail09/00495/12</i>	Ed Elton	Dawn Hermanus dhermanus@saice.org.za
1 – 2 June Cape Town 14 – 15 September Pietermaritzburg 24 – 25 November Johannesburg	Basics of Track Engineering <i>SAICErail09/00496/12</i>	Ed Elton	Dawn Hermanus dhermanus@saice.org.za
15 - 16 September East London 8 - 9 September Johannesburg	Project Management and MS Projects Hybrid Course <i>SAICEproj09/00586/12</i>	Karl Von Buddenbrock	Sharon Muger cpd.sharon@saice.org.za

For more information on courses, venues and course outlines please visit <http://www.civils.org.za/courses.html> or contact cpd.sharon@saice.org.za