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Precast concrete noise barriers **make sound sense for Gautrain**

Of all the many environmental issues faced by the project proponents before the actual construction of Gautrain commenced, the curtailment of noise, both ground and airborne, was a major consideration. This article, written by David Beer on behalf of the Concrete Manufacturers Association (CMA), deals with the steps taken to contain the latter to not more than 65 decibels using precast concrete sound-attenuation barriers, particularly where the rail link runs adjacent to, and in some instances very close to, noise-sensitive built-up environments

IN 2001, WHEN THE Gautrain project was still in its early planning stages, the Gauteng Department of Public Transport, Roads and Works appointed Bohlweki Environmental, now the environmental arm of SSI Engineers and Environmental Consultants, to undertake an environmental impact assessment (EIA) for the project.

Mark Freeman, formerly a director of Bohlweki Environmental and now principal environmental specialist at SSI, says that his company recommended a route alignment that was affordable and would also minimise environmental impacts.

"We looked at all the environmental aspects and made our recommendations based on the outcome of many specialist investigations, including those for noise and vibration. The EIA was ultimately conditionally approved by the regulating provincial environmental authority (now known as Gauteng Department of Agriculture and Rural Development – GDARD). A bidding process to design, construct and operate Gautrain ran in parallel to the EIA and bidders were able to come forward and recommend changes to further reduce environmental impacts.

1 A wall section next to the Gautrain track at Technopark (south of John Vorster Drive), which is panelled with precast concrete sound barriers supplied by Southern Pipeline Contractors (SPC). Important design considerations for the panels were the compaction of the wood-fibre concrete mix to ensure absorption quality and durability, and the geometric shape of the face of the panel to maximise sound absorption

Two of the major concerns identified during the EIA process were noise and vibration. Airborne noise and vibration-generated ground-borne noise were investigated. Derek Cosijn, of Jongens Keet Associates, was appointed to investigate the airborne noise, and Prof Wikus van Niekerk of Stellenbosch University was appointed to investigate the vibration and ground-borne noise. As a first step, baseline measurements were taken along the intended routes in order to determine the existing situation, against which the impact of Gautrain was to be measured. As this was South Africa's first modern railway, they based their research on several modern light-rail systems, including Bombardier's Electrostar, the locomotive and carriage rail unit that was eventually used for Gautrain.

Cosijn and his team set up a model to predict airborne noise based on the parameters given in the US Department of Transport's manual on *High-Speed Ground Transportation Noise and Vibration Impact Assessment*, and the information gained from the investigation of the Electrostar and other light-rail systems. They were then able to advise on the positioning of the sound barriers.

Although modern high-speed trains are generally much quieter than earlier-generation passenger and freight trains, noise is still an important factor to be taken into account in the design of the system and therefore effective noise attenuation was considered crucial to the Gautrain project.

Precast concrete barriers were selected as the most effective means of meeting noise-level requirements in noise-sensitive areas. These barriers are either free-standing or mounted on viaducts or bridge sections. There are many factors that have to be taken into account in the design and placement of noise barriers and if these barriers are not correctly designed,

2 A section of walling on the Gautrain line which has been panelled with fluted precast concrete sound barriers supplied by SPC

3 A wall section next to the Gautrain track 300 m west of Rhodesfield Station panelled with precast concrete sound barriers

4 A wall section next to the Gautrain track at Modderfontein panelled with precast concrete sound barriers

the required attenuation effect will be reduced. Generally, the further away it is from the source, the higher a barrier needs to be. If the wall is too low or too short, the sound waves will diffract past the edges of the structure. If the barrier is not sufficiently dense, then noise will pass through it. If the reflection of sound waves is a problem, then absorbent material needs to be affixed to the reflecting surface. An effectively designed noise-attenuation barrier should reduce the train's noise levels at a receiver point by at least 10 decibels.

Because the quantities of sound-dampening/absorbent material required for the project were substantial, it attracted international interest and companies from North America and Europe visited South Africa to demonstrate their products and technologies.

"We were focused on obtaining acoustic absorption material of the highest quality and the best productivity, and we ran tests at the SABS acoustic laboratory. We also investigated the possibility of making the barriers in-house at our precast yard in Midrand. However, in the end we decided that Southern Pipeline Contractors (SPC), a French-owned company with a local manufacturing facility, would be able to provide us with the noise-dampening performance we required", comments Cyril Attwell, chief concrete technologist of the Bombela Consortium, the bidder eventually selected to design, build and operate Gautrain.

A CMA member company, SPC was commissioned to supply 15 000 m² of the noise barriers for Gautrain. At the time of writing, noise barriers had been installed between Linbro Park and Modderfontein, Marlboro and Rhodesfield, at Pretoria Station and in Hatfield, near the Gautrain Depot and Control Centre in Midrand and at Techno Park in Centurion. Manufacture began in September 2008 and will be completed towards the end of 2010.

Two components of the barrier have been produced by SPC: (1) the normal reinforced concrete barrier panels that make up the fundamental basis of the barrier and (2) the absorptive panels, containing, inter alia, imported wood chips as opposed to the more customary aggregates. Several combinations of foam-concrete and woodchip-concrete absorptive barriers were investigated and in the end it was found that woodchip outperformed foam technology by a considerable margin. Much greater durability was an additional advantage offered by this option and the fluted design of the panels also acts as a sound-dampening mechanism. The sound-dampening wood-fibre chips used in the production of these absorptive panels were imported.

The basic barrier, consisting of precast concrete panels, has been installed at locations along the Gautrain route where noise-sensitive receptors have to be protected from the train noise. In places where sound reflected off the inside of the barriers is a problem, the acoustically absorptive panels have been affixed to the inside of the barrier. In the absorptive panels, wood-fibre concrete, which is light and filled with cavities, captures a large percentage of the noise so that only some of the noise is reflected. Important design considerations for this component were the compaction of the wood-fibre concrete mix to ensure absorption quality and durability, and the geometric shape of the face of the panel to maximise sound absorption.

"Material density was crucial to the whole process because it had a bearing on the acoustic absorption properties of the panels. Lower densities would have given better noise-proofing but durability would have been compromised. So we struck a balance between durability and sound-dampening performance.

"The absorptive panels are 4 m long, 100 mm thick and either 0,75, 1,0 or 1,5 m high. They weigh approximately 130 kg per m². Assembled in a manner similar to precast concrete walls, they are also rot-proof and can be fixed to reinforced concrete panels or existing structures. In Europe, similar wood-fibre concrete barriers have shown no deterioration after 20 years.

"The barriers were manufactured to a life-cycle standard of 100 years, the standard set for all precast elements on Gautrain. This is South Africa's highest-ever standard for any engineering project. As the barriers are load-stressed and of lower durability than other precast elements on the project, we are unlikely to meet this target. However, should a panel fail, in say 70 years time, it can be replaced then," said Attwell.

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Acoustic testing on the SPC sound barriers has taken place at the SABS laboratories in accordance with ISO standards and the barriers have performed well within the set specifications. At the time of writing, acoustic testing on track had not yet been conducted.

"We have conducted manufacturing audits once every six to nine months at SPC to ensure that the chemical composition, grading and texture of the aggregate used to produce the barriers remained consistent as this was crucial to achieving the quality levels we were looking for. SPC is very professional in its approach and we have a great deal of confidence in their quality levels. Although we ourselves checked everything, including the controls and quality assurance procedures, raw materials, mixing procedures, the maintenance of the mixers, the production line and safety aspects, we always regarded SPC as part of our team," concludes Attwell. ◻

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