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Working the danger zone

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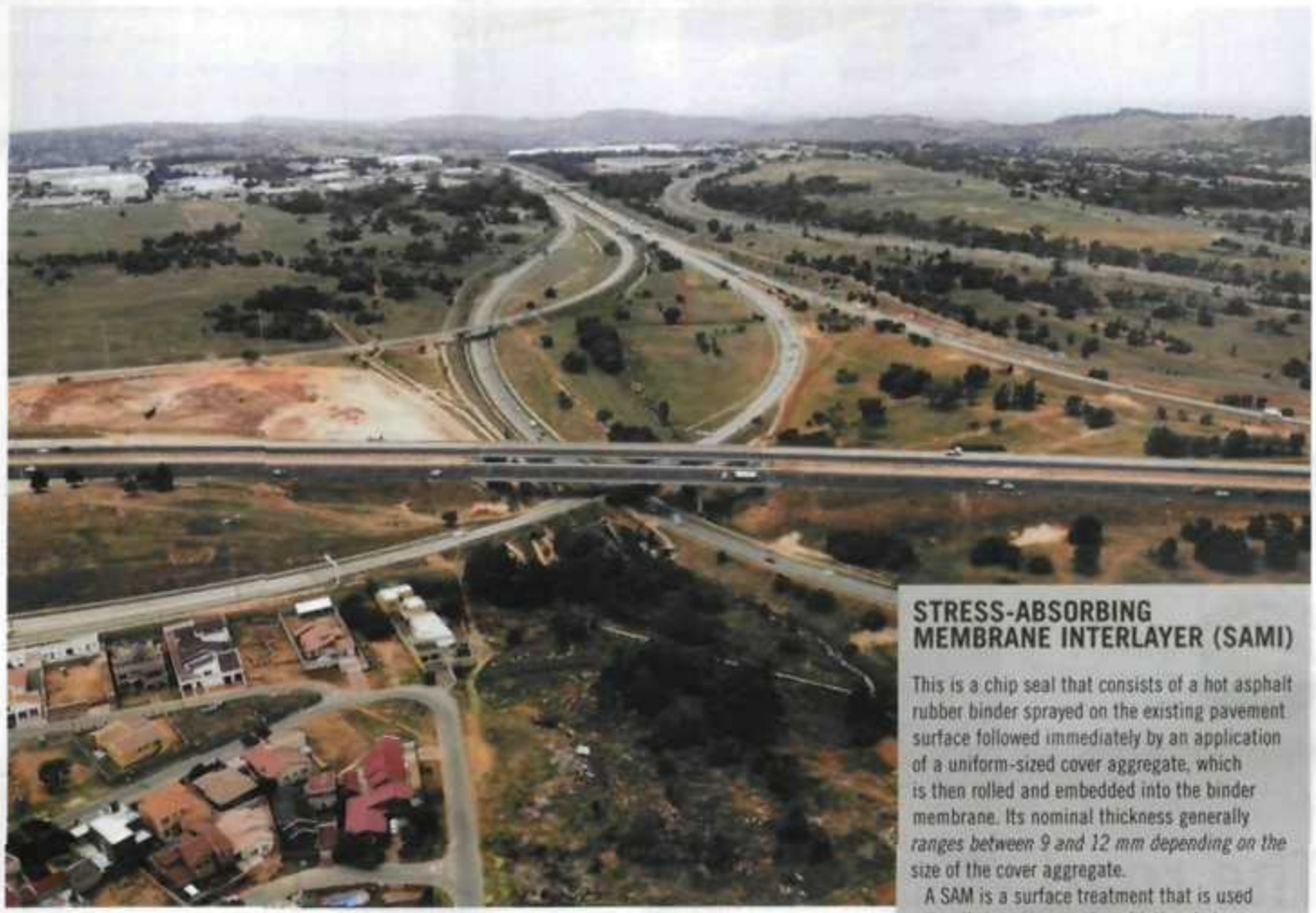

GFIP contractors face two common challenges – deliver against specification, on time and within budget, and try not to get someone killed.

A 13-KM STRETCH OF THE N12 between the Diepkloof Interchange in the west and Alberton in the east, could be regarded as a straightforward road-widening project. However, it is not as simple as it first appeared.

With the overall road reserve limited by width, a substantial portion of the road widening could only be accommodated in the centre space (the median) between the east/west roadways. Moreover, along a 4.9 km section, from the Alberton off-ramp to a point parallel to the Glen Shopping Centre, the east/west roadways sit on two different levels, separated by a sloped, concreted median. Therefore, to widen the highway, the sloped median had to be removed

STRESS-ABSORBING MEMBRANE INTERLAYER (SAMI)

This is a chip seal that consists of a hot asphalt rubber binder sprayed on the existing pavement surface followed immediately by an application of a uniform-sized cover aggregate, which is then rolled and embedded into the binder membrane. Its nominal thickness generally *ranges between 9 and 12 mm depending on the* size of the cover aggregate.

A SAM is a surface treatment that is used primarily to restore surface frictional characteristics, seal cracks, and provide a waterproof membrane to minimise the intrusion of surface water into the pavement structure. SAMs are used for pavement preservation, maintenance, and limited repairs. Asphalt rubber SAMs minimise reflective cracking from an underlying distressed asphalt or rigid pavement, and can help maintain serviceability of the pavement pending rehabilitation or reconstruction operations.

Interlayers can include asphalt rubber chip seal (SAMI-R), fabric (SAMI-F), or fine unbound aggregate.

ABOVE An aerial view of the Diepkloof Interchange near Soweto. The N1 crosses from left to right. The N12 disappears into the distance

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LEFT A section of the N12 near the Reading Interchange. The photograph shows the extent of the retaining wall

and a reinforce-concrete barrier/retaining wall erected to separate the two roadways. Ranging in height from 2.1 to 4.2 m, the 300 mm-thick reinforced concrete wall, with its 400 mm 50% of height width of base to prevent rollover, has been a reasonable challenge. So far, the safety standards required to prevent rollover, the FS factor (or factor of safety) with its minimum measure of 2.0, has been achieved.

Equally, there is another interesting aspect to the reinforced concrete used in highway engineering that requires the highest possible standards when constructed. This is concrete durability or the extent to which it is impermeable. High traffic volumes generate high levels of carbon dioxide, which react with moisture to form carbonic acid (H_2CO_3 or 'acid of air' as the ancients called it). Carbonic acid permeates concrete if the concrete permeability is inadequate. Eventually, it makes its way through to, and reacts with, the reinforcing bars causing corrosion (iron (III) oxides $Fe_2O_3 \cdot nH_2O$) and metal expansion, therefore weakening the structure.

Similarly, sulphuric acid (H_2SO_4) is also soluble in water. As consequence of sulphur being present in certain fuels and being combusted, as in diesel engines, the sulphur in the fuel first burns

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to sulphur dioxide (SO_2), then combines with excess oxygen to form sulphur trioxide (SO_3). In the presence of water vapour, the SO_3 is converted to sulphuric acid. If it permeates concrete, it has the same effect as carbonic acid.

As Derek Nash, on-site laboratory manager, says, "If the compaction of the concrete – the process which expels entrapped air from freshly placed concrete and packs the aggregate particles together to increase the density of concrete, or the suitability (fineness) of the aggregate is inadequate, oxygen will not be eliminated from the concrete and this will give rise to higher permeability. Fortunately, with the collaboration of Afrimix, we have been able to consistently achieve the required standards" he said.

Craig Shearar, site agent for contractors Rumdel Cape, explained that the new road-widening sections, on either side of the barrier/retaining wall, are being constructed off a roadbed with a layer of 150 mm lower select and a layer of 150 mm upper select using natural gravel obtained from a quarry in Muldersdrift. On top of this is a layer of 300 mm stabilised subbase using cement supplied by Afrisam. Above this is a 90 mm layer of bitumen-treated base topped with a 50 mm bitumen rubber asphalt semi-open (BRASO) layer (see side box). Where existing concrete road exists, it is checked for defects and repaired using fast-setting concrete mixtures and the entire

BITUMEN RUBBER ASPHALT SEMI-OPEN (BRASO)

In simple terms, bitumen rubber asphalt is a blend of asphalt, reclaimed tyre rubber and extender oil, with a pinch of calcium carbonate. Nico Wilcocks, technical manager at Roadspan and a leading proponent of this technology, explains the process.

A bitumen rubber binder is manufactured by blending penetration-grade bitumen, 60/70 or 80/100, with rubber crumbs, usually between 18% and 22% by weight (of the total blend) with a 2% by weight extender oil. The bitumen rubber blend is circulated in a holding tank and heated to temperatures (190 – 210°C) to facilitate the chemical digestion process. Once ready, the binder is used to produce asphalt, or premix, as it is also known, by adding aggregate and cement or lime to improve adhesion, and mixed in a patented high-speed blender at 3 000 rpm.

The rubber is obtained by recycling old tyres and taking tyre tread sculpings and producing rubber crumbs by means of a mechanical comminuting process. Crumbs produced by cryogenic-mechanical techniques are not permitted in South Africa. The rubber must be pulverised, free of fabric, steel cords and other contaminants. Natural rubber, typically found on tractor and truck tyres, digests a lot quicker than the synthetic rubber found on most motor cars. A maximum of 4% by mass of fine particle-size calcium carbonate, or talc, may be added to the rubber crumbs to prevent the rubber particles from sticking together. The crumbs must be free flowing, dry and comply with specific requirements.

The extender oil is added to improve the viscosity of the asphalt so that it does not place a strain on pumps etc.

Semi-open refers to the aggregate gradation and quantities used in the premix.

BRASO POSTPONES SOLID WASTE 'NIGHTMARE'

Renshaw, Hoffmann and Potgieter, in a paper published through the University of Pretoria, point out that the disposal of scrap tyres is a major problem throughout the developed world. Approximately 300 million scrap tyres have to be disposed of every year in the USA alone and some 89 million in the UK. This gives scale to the problem.

In these countries, scrap tyres are dumped on large landfill areas that contain between 5 and 15 million tyres. In the USA, fires at these sites have been known to burn from three to nine months, resulting in costs of up to US$6 million (approximately R45 million) per fire. These fires also produce ground and air pollution as just one tyre contains roughly 3.8 ℓ of oil.

In developing countries such as China, India, and South Africa, economic growth rates have been consistently higher in recent years. This has improved standards of living, which has led to an increased credit spend that has resulted in more cars coming onto the roads. In addition, more cars, more scrap tyres.

With the increased use of the bitumen-rubber-asphalt technology on roads, this will greatly reduce the solid waste problem posed by scrap tyres.

existing concrete road will be given a stress-absorbing membrane interlayer (SAMI) (see side box) and a 40 mm BRASO layer above that.

However, the biggest and by far the most dangerous challenge was managing road traffic. To road users, this particular

Motorists along this route simply ignore the designated 80 km per hour speed limit while construction is going on

stretch of road, perhaps because of its roller coaster feel, is a veritable racetrack. UWP/Nyeleti's Pieter Steenkamp, overall RE on the project, describes this section of highway as a danger zone. Cars, motorcycles and even a few trucks, fortunately not all, scream along at speeds far in excess of the designated 80 km/h speed limit – imposed while construction is underway. Even with the heavy concrete safety barriers in place, it is extremely intimidating. At certain points along the route, exit/entry points to the work area are dangerous. Because the speed at which irresponsible road users are driving – and despite traffic delineators clearly visible up to 500 m away, plus two flagmen signalling the entry/exit points – drivers do not always have the time or space to move into the left lane and collide with slow-moving trucks entering or exiting the work area in the median.

Sadly, and frustratingly, despite facts and figures being supplied to the Johannesburg and Ekurhuleni metropolitan police forces, there has not even been a visible policing presence, let alone traffic law enforcement. Between them, they do not always agree to who is responsible as the project straddles both metros.

Nonetheless, so far so good! SANRAL (the client), the UWP/Nyeleti JV (the consulting engineers and and Rumdel Cape (the contractors) have done a sterling job with the project on track and within budget. 3S

BELOW Workers prepare reinforcing bars and shuttering for a concrete pour