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Rehabilitating a critical airstrip

Rebuilding and extending the Rubkona gravel runway in South Sudan paved the way for larger-bodied fixed-wing transport aircraft servicing a humanitarian aid station and refugee camp for internally displaced people. Faced with a range of options, WSP Group Africa devised a value engineering approach that cut costs significantly and provided a lasting solution. **By Alastair Currie**

High aircraft traffic volumes had progressively taken their toll on Rubkona's airstrip, which had become heavily corrugated, with ensuing gravel loss. This was progressively exacerbated by the geology and the wet and dry extremes experienced in the region. During the rainy season, typically extending from May to October, air traffic for fixed-wing aircraft was restricted to intermittent dry runway days.

Up to 48 hours were required for the airstrip to dry out sufficiently for the safe landing of fixed-wing aircraft. During the summer months, the underlying black cotton soils also meant that severe and deeper-level surface cracking occurred – large enough to insert a closed hand – making the runway unsafe for planes.

Characterised as expansive clays, black cotton soils have a high potential for shrinkage or swelling, subject to moisture variables. On this site, these soils reach a depth of up to 15 m deep, with a silty-sand layer below.

Road transport would have been an alternative option, but the general state of infrastructure is poor to the point where the route becomes non-negotiable in wet periods, hence the reliance on aviation. So when planes couldn't land, this meant that inbound logistics for the aid mission had to be supplied by military-scale helicopters. However, given the much higher fuel burn rate of rotary aircraft, this added a greater payload cost.

Need for larger planes

The client brief to WSP was to come up with a design solution that would restore and then extend the runway to accommodate larger transport planes, like Lockheed Martin's C-130 Hercules and its civilian variant, the L-100-30 Hercules – all year round. These aircraft are equipped to carry a cargo of approximately 19 tonnes. Prior to the upgrade, the Antonov An-26, with its approximately 5.5 tonne payload, was the largest plane that the airstrip could handle.

"During construction, a key requirement was for the airstrip to remain open to traffic," explains Hercu du Preez, principle associate: Pavements – Transport and Infrastructure, WSP Group Africa, who led the project.

"For this reason, the works were split into two phases. The first phase entailed the rebuilding of the existing 800 m airstrip, followed in Phase 2 by extension works to establish the final 2.2 km runway," he continues.

Sourcing the layer works materials was an immediate challenge that subsequently had a major influence on the approved design. This resulted in WSP specifying the application

Each geocell panel measure 2.5 m x 10 m. Using on-site labour, these are stretched out and stitched together

“With routine maintenance, WSP’s design will ensue that the Rubkona airstrip will remain functional and serviceable over its 10-year design life.”

of polymeric nanocomposite alloy geocells as the preferred mechanically stabilised and accepted construction methodology. Compared to alternative HDPE options, polymeric nanocomposite alloy geocells have exceptionally high creep resistance, which is an essential feature for runway construction. Permanent deformation of the geocells occurs due to constant loading. Equivalent HDPE systems are not designed to achieve this result and are, therefore, unsuitable for this application.

“Geocells have a 3D honeycomb shape and each cell is filled with material to form its final integrity. At Rubkona, this comprised white silty sand sourced from a local borrow pit,” says Du Preez, adding that by confining the material, the modulus of elasticity is improved significantly, depending on the nature of the supporting layer. In this case, that was another geocell layer.

“To accommodate larger planes, you need maximum stiffness in the upper pavement layers and this was optimally achieved with the geocells,” he continues. “Thanks to the design, we were also able to keep the pavement as light as possible, to reduce the risk of any potential settlement.”

The final design

After detailed assessments, the approved layer works design comprised the following:

- a 150 mm gravel wearing course composed of G6-G7 ferricrete material, referred to locally as Murram
- a 150 mm white sand layer mechanically stabilised with a 100 mm geocell grid
- a further underlying geocell grid layer to the same specification
- a 40 kN geotextile separation layer above the underlying black cotton soil.

The sand stockpiles are back-tipped on-site and then the successive windrows are bladed into the cells using a grader

The original construction cost using a conventional chemical stablisation methodology was estimated at around $US27 million (R393 million), making it a non-starter. The accepted WSP design came in around approximately $10 million (R145.5 million), which then received the green light.

Thanks to the black cotton soils, the conventional design would have required around 600 mm of Murram to form the wearing course. But the source of the nearest Murram commercial aggregate was situated some 160 km away. Aside from the sheer distance and the constant risk posed by civil unrest, the roads leading to the site were in too poor a condition to enable on-time project delivery. Therefore, importing this wearing course was cost-prohibitive.

A calculation also showed that by going the chemical stabilisation route, at least 1 000 truck-loads of cement or lime would have been needed for the project. So going the geocell route made things much simpler: packed in containers, they were all flown in by Antonov An-26 aircraft. An alternative G6-G7 material was also sourced closer by, for the gravel wearing course.

Construction began in November 2017 and was completed in May 2018, which is a remarkably short time frame for a project of this nature.

“Thanks to a geocell solution, fixed-wing aircraft approaching Rubkona airstrip can now land every day of the year, given permissible flying conditions,” Du Preez concludes. 3S

Applying the final 150 mm gravel wearing course

Geocell establishment at an advanced stage of construction

A transport aircraft parked on the new runway apron